

IDEOLOGICAL EVOLUTION
THE COMPETITIVENESS OF NATIONS IN A GLOBAL
KNOWLEDGE-BASED ECONOMY

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by

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ABSTRACT

My objective is to deepen and thicken public and private policy debate about the competitiveness of nations in a global knowledge-based economy. To do so I first demonstrate the inadequacies of the Standard Model of economics, the last ideology standing after the Market-Marx Wars. Second, I develop a methodology (Trans-Disciplinary Induction) to acquire ‘knowledge about knowledge’. In the process of surveying the event horizons of seventeen sub-disciplines of thought, I redefine ‘ideology’ as the search for commensurable sets or systems of ideas shared across knowledge domains and practices. Third, I create a definitional avalanche about knowledge as a noun, verb, form and content in etymology, psychology, epistemology & pedagogy, law and economics. In the process I demonstrate that personal & tacit and codified & tooled knowledge are the staple commodities of the global knowledge-based economy. Fourth, I establish the origins and nature of the Nation-State, the shifting sands of sovereignty on which it stands and the complimentary roles it plays as curator, facilitator, patron, architect and engineer of the national knowledge-base. Fifth, I examine the competitiveness of nations with respect to a production function in which all inputs, outputs and coefficients are defined in terms of knowledge. In the process, I demonstrated that competitiveness, as Darwinian win/lose against rivals, is inadequate because it does not account for the mutualism of symbionts and environmental change, *i.e.*, coevolution and coconstruction. Accordingly, I propose ‘fitness’ as a more appropriate criterion for the competitiveness of nations in a global knowledge-based economy. Finally, I consider the comparative advantage of nations given their initial and differing national knowledge endowments.

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1.0 INTRODUCTION

1. In his April 25, 2005 'State of the Union' address to the Duma, Vladimir Putin, President of the Russian Federation, called the collapse of the Soviet Union in 1989 "the greatest geopolitical catastrophe" of the twentieth century (BBC April 25, 2005). Whether true or not, this event, accompanied by the nearly synchronistic conversion of Communist China to market economics marked the end of the Market/Marx Wars which had raged and divided the world for almost a century and a half beginning with publication of the *Communist Manifesto* by Karl Marx and Frederick Engels in 1848.

2. The Communist Revolution failed. The previous Republican Revolution survives. A world divided and threatened with nuclear winter for almost half a century now rallies around the last ideology standing – market economics with its political and legal corollaries: popular democracy and private property. This is not, however, the end of ideology (Bell 1960) nor of history (Fukuyama 1992). Now that the fog of war has dissipated, it is time to reconsider both victor and vanquished. Glorification of 'us' and demonization of 'them' are byproducts of war - hot, cold and ideological; reflection and reconciliation are byproducts of peace.

3. The word 'ideology' has many meanings today (Gerring 1997) but was coined simply enough by Condillac, a contemporary of Adam Smith (1776), to mean 'the science of ideas' (OED, *ideology*, 1a). Separation of Church and State was critical to both American and French Republican Revolutions. Creation of a secular 'science of ideas' to counter the awe and mystery of religious and metaphysical thought and ritual was part of a revolutionary agenda designed to overthrow an Ancient Regime of subordination by birth.

4. The antagonistic relationship between religion and secular ideology today appears, in its most virulent form, in the guise of *Al Queda* and a jihadist radical Islamic campaign of terror against 'the West'. However, the West itself remains divided between resurgent religious fundamentalism (faith) and a secular ideology of science (knowledge). Of this global dilemma, Carl Jung wrote:

The rupture between faith and knowledge is a symptom of the split consciousness which is so characteristic of the mental disorder of our day. It is as if two different persons were making statements about the same thing, each from his own point of view, or as if one person in two different frames of mind

were sketching a picture of his experience. If for “person” we substitute “modern society,” it is evident that the latter is suffering from a mental dissociation, *i.e.*, a neurotic disturbance. In view of this, it does not help matters at all if one party pulls obstinately to the right and the other to the left. (Jung [1956] 1970, 285)

5. If technology *cum* Heidegger (1955) enframes and enables us as physical beings within a human built environment then ideology (inclusive of religion) enframes and enables us as mental beings within local, regional, national and global communities of ideas. It is this enframing and enabling of minds within systems of ideas that forms, in part at least, what theoretical biology calls the noösphere, *i.e.*, “that part of the world ... [consisting of human] conceptual thought... as opposed to the geosphere, or nonliving world, and the biosphere, or living world (Encyclopedia Britannica 2003).

6. Today, with the exception of North Korea and Cuba, no Nation-State on earth subscribes to economic Marxism while the People’s Republic of China struggles to reconcile private property and the marketplace with the political clarity of Leninism (M. Polanyi 1957, 480). (In this view, conversion is a necessary yet distasteful, temporary detour on the road to perfect communism.) Nonetheless, virtually all Nation-States are either current or expectant members of a World Trade Organization (WTO) rooted in the ideology of the marketplace.

7. Ideologies are, if you will, organisms capable of adaptation, growth, mutation, recombination and symbiosis. They may also exhibit “avalanches of speciation and extinction” (Kaufmann 2000, 216). This metaphor of avalanches of change has been extended by Kauffman from molecular biology or genomics to the economy or what he calls the ‘econosphere’. He draws a parallel with Joseph Schumpeter’s description of technological change as the “gales of creative destruction” (Kauffman 2000, 216; Schumpeter 1950, 81-86). He also suggests its application to the growth and development of human culture and knowledge. It should not therefore be surprising that just as the former Second World of centrally planned economies melted into a single global marketplace, the economies of the First World were shifting from a foundation based on manufacturing to one based on knowledge.

8. Similarly, it should not be surprising that as the knowledge-based economy emerged the definition of knowledge itself underwent what amounts to a scientific revolution (Kuhn 1996). An old philosophy of science modeled on the ‘when-then’ causality of physics (Grene & Depew 2004, 95) is increasingly being displaced by *causality by purpose*, both natural purpose in biology and human purpose in works of aesthetic, intellectual and technological intelligence (Aldrich 1969). The emerging science of genomics arguably represents a marriage of both natural and human purpose.

9. Ideologies, as organized systems of ideas, concern therefore both human nature and Nature herself. The later are generally called ‘sciences’. To classify the scientific study of Nature as ideology may sound strange to some but as Michael Polanyi has written “the very substantial flaws which the rigorously positive conception of science contains ... requires to be supplemented by fiducial elements - which I shall call ‘scientific beliefs’ - if we are to draw a true picture of science.”(M. Polanyi 1950, 27).

10. ‘Belief’ is a characteristic of ideology, not of traditionally narrow ‘positivistic’ science. Ideologies concerned with human nature, on the other hand, even when portrayed as ‘scientific’, e.g., Marxism-Leninism (M. Polanyi 1957), are fundamentally flawed. This is due to their object – humanity - which remains far more opaque to understanding than Nature revealed over four centuries of the experimental method. This varying transparency may simply reflect the ascending complexity of physical, biological and intellectual forms or, alternatively, levels of analysis, i.e., geosphere, biosphere and noösphere.

11. In this presentation I am concerned with the meaning of ‘knowledge’ and how it affects the competitiveness of nations in a global knowledge-based economy. In a way, such an economy is the ideological part of the noösphere involved with the buying and selling of ideas as well as other knowledge transactions including those in the public domain. After formal definition of the problem (2.0 Problem: A Flawed Ideology) and the methodology adopted to resolve it (3.0 Methodology: Trans-Disciplinary Induction), I will introduce increasing detailed of definition of knowledge as a noun, verb, form and content.

12. First, I will define knowledge as a monotonic abstract Platonic noun like Beauty, Truth and Justice (4.0 Knowledge as Noun). I will demonstrate that this definition is rooted in the undifferentiated but polymorphous biological human need to know. Knowledge, as noun, also exhibits immeasurability and incommensurability finding general expression through inherently limited and biased human languages including mathematics and English. Knowledge as a noun will serve as the material cause of knowledge.

13. Second, I will define knowledge as a diaphonic verb ‘to know’ invoking two alternate yet complementary ways of knowing, i.e., Science and Design, or rather, knowledge acquired through reductive and/or constructive methods (5.0 Knowledge as Verb). I will examine each, their historic relationship and propose a reconciliation to satisfy Kauffman’s hope “to glimpse a *constructivist* companion to the reductionist thesis” (Kauffman 2000, 268). Knowledge as a verb will serve as its efficient cause.

14. Third, I will define knowledge as physical form including personal & tacit, codified and tooled knowledge ([6.0 Knowledge as Form](#)). The last – tooled knowledge - constitutes what is conventionally called technology, the technology that enframes and enables extending the human senses and grasp of the natural world. These, in turn, take form as inputs to, and outputs of, a knowledge-based economy. As inputs, knowledge takes form as: (i) codified & tooled capital, personal & tacit labour and toolable natural resources. As outputs, it takes form as (ii) the Person, Code and Tool. I will also demonstrate that codified and tooled knowledge acquire meaning or function only when mediated by a natural Person. Put another way, all knowledge is ultimately personal & tacit. Knowledge as form will serve as its formal cause.

15. Fourth, I will define the content of knowledge ([7.0 Knowledge as Content](#)) with respect to etymology (Chapter 8), psychology (Chapter 9), epistemology & pedagogy (Chapter 10), law (Chapter 11) and economics (Chapter 12). Knowledge as content will serve as its final cause.

16. Fifth, I will examine the nature of the Nation-State, consider the shifting sands of sovereignty on which it stands and outline its governance as custodian, facilitator, patron, architect and/or engineer of the national knowledge-base ([13.0 The Nation-State](#)). It is here that the increasing depth and density of definition of knowledge takes hold and hopefully “where knowledge is an essential part of the system, knowledge about the system changes the system itself” (Boulding 1966, 9).

17. Sixth, I will then consider the competitiveness of nations using a production function in which all inputs, outputs and coefficients are defined in terms of knowledge. I will then consider comparative advantage with respect to knowledge as a noun, verb, form and content ([14.0 Competitiveness](#)). Furthermore, I will displace the contemporary sports metaphor of competitiveness - ‘win/lose’ - with the biological metaphor of fitness to adapt to a rapidly changing economic landscape through coevolution and coconstruction with other Nation-States or, more generally, with other “autonomous agents” (Kauffman 2000).

18. Seventh, and finally ([15.0 Conclusions](#)), I will offer three sets of closing comments about knowledge, the production function and the Nation-State. The first set will involve the causal hierarchy of knowledge, ‘dirty hands’ from its misapplication and ideological commensurabilities between knowledge domains. The second will concern the production function for a knowledge-based economy. It is here that I introduce a labour theory of knowledge. The third and final set of conclusions will concern the fragility of the Nation-State, its role as prime attractor in a global knowledge-based economy, the limits of comparative advantage and the ideological coevolution of the Nation-State and economics.

2.0 PROBLEM: A FLAWED IDEOLOGY

1. An ideology, for my purposes, is a system or set of ideas defining a distinct sector of the noösphere, *i.e.*, of human thought, such as science, religion, politics, philosophy, economics, business & commerce, art & entertainment, *etc.* Such systems adapt, grow, evolve, coevolve, mutate and/or become extinct over time. Speciation occurs with new species forking off from a common stock. In the West, the experimental sciences broke off from natural philosophy in the 17th century. In the 18th century, Art and aesthetics separated from theology or metaphysics while economics broke off from moral philosophy. Then, late in the 19th century, most of the other social sciences emerged out of moral philosophy. Arguably such division and specialization of knowledge is a characteristic of maturing and stable human societies – civilized or otherwise. Broadly defining those holding a specific ideology as ‘interest groups’:

the longer a society has been able to enjoy stability the more numerous will be the number of special interest groups it sustains. Revolutions, foreign invasions and dictatorships, and so on, are inimical to the slow and difficult growth of special interest organizations. (Beckerman 1983, 916-917)

2. Ideologies, arguably, grow from a single idea that attracts more and more ideas, connects them, creating a web of thought that enframes human definition of a specific sector of the noösphere, or the noösphere itself, at a given point in time. Intellectual mass accumulates until there is an ideological avalanche *cum* Kauffman (2000). Obvious historical examples include mass religious conversions of entire societies, for example, from polytheism to Christianity in the Roman Empire; from Zoroastrianism and Christianity in Persia and the Byzantine Empire, respectively, to Islam; from Shinto and Taoism in Japan and China, respectively, to Buddhism. Others, of course, include the Republican and Communist Revolutions.

3. Ideology, as a system of ideas, provides a background or framework of subsidiary knowledge that can be taken for granted, that remains tacit, while one focally attends to a specific question, concept or idea (M. Polanyi Oct. 1962). This is similar to the operation of ‘normal science’ identified by Thomas Kuhn. Once a ‘paradigm’ has emerged in a natural science, focal attention shifts to ‘puzzle solving’ (Kuhn 1996). Kuhn also observed that: “Over

time a diagram of the evolution of scientific fields, specialties, and sub-specialties comes to look strikingly like a layman's diagram for a biological evolutionary tree" (Kuhn 1990, 7-8).

4. It is important to note, however, that Kuhn's 'new' philosophy of science (Idhe 1991, 11-44) has a more immediate relationship to ideology and the Cold War. The 1962 first edition of Kuhn's seminal text, *The Structure of Scientific Revolutions*, was written over:

a fifteen-year incubation period (1947-1962), during much of which he taught in the General Education in Science curriculum designed by Harvard President James Bryant Conant, who wrote the foreword to Kuhn's first book and to whom *Structure* is dedicated. (Fuller 1992, 262).

5. According to Steve Fuller, in his biography *Thomas Kuhn: A Philosophical History of Our Times* (Fuller 2000), Conant's agenda was to protect: (a) funding for 'pure science' from the 'dirty hands' problems of the atomic bomb; (b) young scientists from pernicious Marxist influences; and, (c) academic science from "potentially antiscientific academics [by having them] become scientists themselves" (Fuller 1992, 241). In this regard, Feyerabend, a noted philosopher of science of the day, in a letter written to Kuhn after reading the final draft described *Structures* as "ideology covered up as history" (Fuller 2000, 71, 90n). In this light Fuller's observation that "Good paradigms make good neighbors" (Fuller 2000, 7) takes on ideological or enframing implications. Stay within your own ideology, within your own system of ideas. Do not cross disciplinary, sub-disciplinary or speciality borders. Do not trouble yourself with politics, it is another paradigm. Respect your neighbours' fences. Trust the experts. Arguably, the term 'paradigm' was for Kuhn a politically correct way of saying 'ideology'.

6. Glorification of the 'pure' scientist, demonization of public and private direction of science combined with trust in the free market was, however, an ideology Kuhn shared with chemist and philosopher of science Michael Polanyi. Polanyi, however, went even further framing the natural sciences in terms of free market economics in his "Republic of Science" (Polanyi 1962b). Kuhn, however, triumphed, initially at least, with 'paradigm' and its ideological accoutrements - the incommensurability of knowledge, the sociological nature of science and paradigmatic puzzle solving. These restructured discourse in the philosophy of science, the humanities & social sciences as well as science policy. *Structures* arguably became "one of the most influential books of this century" (Fuller 1992, 241). With the knowledge-based economy, however, Michael Polanyi's ideology has gained renewed intellectual and policy relevance. Ironically, so has the seminal work of his brother, economic anthropologist Karl Polanyi whose *The Great Transformation* (K. Polanyi [1944] 2001) is the story of the birth

of the free self-regulating market in early 19th century Western Europe which some argue, including myself, bears directly on the emergence of the global self-regulating knowledge-based economy of the 21st ([Munck 2002](#)).

7. And it is to the origins of this global knowledge-based economy, and the flawed ideology – market economics - underpinning it, to which I now turn.

2.1 Origins

1. In 1995 the World Trade Organization (WTO) began operations and a new global economy was born (WTO 1994a). Today, 2005, virtually all member states of the United Nations (UN) belong to the WTO with the notable exception of the Russian Federation. Put another way, global regulation of political and military competition by the UN beginning in 1945 was extended to global regulation of economic competition by the WTO fifty years later. This was possible only because of the global triumph of the Market over Marx.

2. For the first time, virtually all nation-states agreed to abide by common rules of trade recognizing the WTO as final arbitrator of disputes and authorizing it to sanction countervailing measures against offenders of its rules. Given the historical role of trade disputes fueling international conflict, the WTO compliments the UN as a bulwark of international peace, law and order.

3. As an international legal instrument, the WTO is a ‘single undertaking’, *i.e.*, it is a set of instruments constituting a single package permitting only a single signature without reservation. One of these instruments is the Trade-Related Intellectual Properties and Services Agreement (TRIPS, WTO 1994b) that constitutes, in effect, a global agreement on trade in knowledge, or more precisely, in intellectual property rights (IPRs) such as copyrights, patents, registered industrial designs and trademarks. TRIPS is, however, but one part of the complex WTO package that includes the General Agreement on Tariffs and Trade (GATT) and twenty-six other technical agreements.

4. TRIPS, in turn, exists in the context of a constellation of international agreements, conventions, covenants and treaties administered by the World Intellectual Property Organization ([WIPO 1979](#)) a special subject agency of the United Nations. TRIPS requires accession to some but not to all WIPO instruments. In turn, WIPO instruments apply only to Nations-States that accede to them. Generally, acceding States provide only ‘national treatment’ to citizens of other States, *i.e.*, the same rights are extended as if they were nationals but the rights so extended are defined by each national legislature. This treatment contrasts with

‘harmonization’, characteristic of other WTO efforts, *e.g.*, definition of subsidies. Currently ‘in force’ WIPO instruments, as well as TRIPS, ignore and thereby deny protection to ‘non-marketable’ intellectual property rights, *e.g.*, aboriginal heritage rights (Farrer 1994; [Chartrand 1995](#)) including rights to traditional ecological knowledge or (TEK) as well as collective or community-based intellectual property rights in general (Shiva 1993). Such ignored rights, together with commercial rights that have lapsed through time, constitute the public domain of knowledge from which any and all may freely draw.

5. In 1996, the Organization for Economic Cooperation and Development (OECD), whose members constitute the First World of developed, democratic market economies, published [The Knowledge-Based Economy](#) (OECD 1996). The next year the OECD published guidelines for competitiveness in this new economy: *National Innovation Systems* (OECD 1997).

6. Creation of the WTO and recognition of the knowledge-based economy by the OECD initiated an avalanche of change. Almost immediately, rapid institution building began, continuing to this day, in public and private sectors around the world. A new specialty emerged – ‘knowledge management’, not to be confused with its predecessor - information management; the ‘Chief Knowledge Officer’ (CKO) is becoming an hierarchical feature of multi- and trans-national corporations; governments are creating knowledge ministries, departments and agencies; ‘knowledge audits’ are being conducted by firms and nation-states around the world ([Malhorta 2000](#)); and, nation-states themselves are designing ‘national innovation systems’ (NIS) to generate and market new knowledge (OECD 1997). Even a standardized lexicon or vocabulary is being drafted to guide public and private sector discussion and debate ([American National Standards Institute and the Global Knowledge Economics Council 2001](#)).

7. Only time will tell whether all this conceptual and institutional activity is a passing policy fad or marks a true evolutionary leap in economic development and thinking. What is certain is that knowledge is now recognized as a strategic asset in the competitiveness of nations. What is equally certain, however, is that the ‘Standard Model’ of economic thought is theoretically inadequate to deal with this new economy.

2.2 The Standard Model

1. Economics has what I will call a ‘Standard Model’, *i.e.*, a generally accepted theoretical model. It is taught in geometric, mathematical and deductive terms using standardized textbooks in first and second year university courses around the world from Adelaide, Beijing, Budapest, Cambridge, Cape Town, Moscow, Paris, Saskatoon, Stockholm to Washington D.C.

2. The Standard Model was developed during the last quarter of the 19th and first quarter of the 20th centuries particularly in the hands of Alfred Marshall (1842-1924) at Cambridge University (Marshall 1920). Alternatively known as the Marshallian, Neoclassical or Perfect Competition Model, it fulfils Descartes' requirement of a science in that it uses deductive logic based on a set of key assumptions whose conclusions are subject to geometric and mathematical proof. The resulting 'paradigm' led, I infer, Thomas Kuhn to single out economics among the other social sciences as best approximating 'normal science' (Kuhn 1996, 161).

3. It is important to note, however, that while Alfred Marshall contributed, among other things, the iconic centerpiece of the Standard Model, the 'X' formed by demand and supply curves (often called the 'Marshallian scissors'), Marshall himself held a much more subtle, complex and biological view of the economy. As with the work of many great economists including Adam Smith, some of Marshall's work became part of the canon while other parts were forgotten. This includes his "emphasis on the contribution of knowledge to capital, the relationship between various forms of organisation and knowledge and the importance of 'the tendency to variation' in generating progress" (Loasby 1990). As will be seen, however, Marshall's biology was limited by the science of his time, specifically to the Darwinian principle of natural selection through 'survival of the fittest'. More recent findings such as coevolution and coconstruction were not available to him and will play a critical role in my subsequent distinction between the *competitiveness* and *fitness* of nations.

2.2.1 Epistemology

1. Unlike the other humanities & social sciences, economic epistemology, *i.e.*, its theory of knowledge, is rooted not in Platonic or Aristotelian idealism but in Epicurean sensationalism. As noted by Marshall (1920, 628), the most influential successor of Adam Smith (1723-1790) was not an economist but rather Jeremy Bentham (1748-1832), a radical reformer who formalized Utilitarianism as a comprehensive philosophy (Clough 1964, 605). Bentham's epistemology is based on the atomic materialism of Epicurus (341-271 B.C.E.). He acquired this view from the *De Rerum Natura* (*On the Nature of Things*) by the Roman Epicurean poet Lucretius (99-55 B.C.E.), whose work, unlike those of Epicurus, survived the fall of the Roman Empire and the censorial fires of the Church.

2. Like Epicurus, Bentham believed that physical sensation was the foundation of all knowledge. Knowledge, including preconceptions such as 'body,' 'person,' 'usefulness,' and 'truth', form in the material brain as the result of repeated sense-experience of similar objects. Ideas are formed by analogy between or compounding such basic concepts (O'Keefe 2001).

3. The idea that the physical brain records and processes (engrams) sensations into higher order constructs such as consciousness is a contemporary conclusion of cognitive and neuropsychology (Freeman 1999). It can be explained through ‘circular causality’. A higher, macro or ‘transcendent’ order of physical nature results from a specific relationship between micro-parts that, once attained by chance, natural selection or otherwise, cause the resulting macro order to feed back on these parts to maintain itself. This involves not just a mutual reinforcing feedback (homeostasis) between a whole and its parts but also maintenance of the relationship between the parts themselves. In philosophical terms, circular causality creates a self-perpetuating epiphenomenon, *i.e.*, a secondary phenomenon accompanying another and caused by it. Or, in aesthetic terms: “if we can regard beauty as a certain unity of diverse elements, perhaps harmony can be understood as the relation of these parts to the whole, and rhythm as their relation to one another.” (Dorter 1973, 74-75)

4. For Bentham sense experiences involved a unit measure of pleasure and pain called the ‘utile’ from which the philosophical school of thought known as ‘Utilitarianism’ emerged. Utiles would eventually, according to Bentham, be subject to physical measurement and he proposed a ‘felicitous calculus’ of human happiness. One corollary of the utile, however, is that customs, traditions and taste cease to be independent variables. Compulsory standard education would ensure, Bentham believed, that everyone’s customs, traditions and taste would eventually become identical and therefore irrelevant.

5. Even aesthetics shrank to analysis of pleasurable sensations evoked by a work of art. A thing is beautiful because it pleases, it does not please because it is beautiful (Schumpeter 1954, 126-7). This, combined with Benthamite emphasis on functionality, meant application of artistic effort was “irrational”. In industrial design and architecture, this aesthetic reached its logical conclusion in the aphorism *form follows function*, the Bauhaus and the glass and steel towers of the International School of Architecture (Hughes 1981).

6. In the hands of Francis Ysidro Edgeworth (1845-1926) Bentham’s felicitous calculus of human happiness was married to Newtonian calculus of motion and reduced to geometric expression subject to mathematical proof in his *Mathematical Psychics* (Edgeworth 1881). This geometry and its related calculus permitted erection of what became the Standard Model in economics. It is important to note that use of calculus defines the Standard Model as mechanical rather than biological in nature, *i.e.*, the calculus of motion, in this case, of human happiness.

7. The budget (income and prices) constrains maximization of pleasure by the individual consumer yielding a demand curve while the cost constrained profit maximization of the firm

yields a supply curve. When put together in the ‘Marshallian scissors’ of supply and demand, a determinant geometric, mathematically precise equilibrium emerges. It is an ideology framed by an ‘X’ - the intersection of market supply and demand curves - marking the spot where human happiness is to be found, where, at one and the same time, consumers maximize their self-interest and producers their profits; everyone is happy here - if one accepts certain very strict assumptions.

8. For my purposes, three assumptions are relevant. First assume all consumers and producers have ‘perfect knowledge’ in which case, of course, there can be no market for knowledge since everyone has it freely and perfectly. Second assume that human beings are strictly rational, *i.e.*, they are constantly calculating and weighing the relative probabilities of present and future pleasure against present and future pain. Third, while utiles cannot be physically measured let us assume they can be reified, *i.e.*, an abstraction made concrete, in the form of money. The presence of money brings pleasure; its absence brings pain. It is ironic that the Standard Model in economics achieves what Plato, speaking about Art, feared most, that: “not law and the reason of mankind, which by common consent have ever been deemed best, but pleasure and pain will be the rulers in our State” (Plato 1952, 433-434).

9. Unlike the Standard Model in sub-atomic physics (Cottinham & Greenwood 1998), however, the economic model is not empirical, *i.e.*, it does not reflect nor pretend to reflect observable reality. Furthermore, it is not experimental, *i.e.*, controlled conditions cannot be maintained nor results replicated. Rather, the Standard Model in economics is normative, specifying conditions under which perfection can be attained, providing the benchmark against which economic reality can be judged, *e.g.*, the cost of monopoly. It is therefore a ‘theory of value’ reflecting the origins of economics as a branch of moral philosophy (Boulding 1969). In this sense, the Standard Model of economics is indeed an ideology.

10. Beyond normative and pedagogic uses, however, the Standard Model also serves as a ‘straw man’. By changing component assumptions, economists use the Standard Model to generate different outcomes. It is these outcomes rather than those of perfect competition that are generally compared with economic reality, *e.g.*, independent discovery of solutions for monopoly and monopolistic competition by Chamberlin (1933) and Robinson (1933).

2.2.2 Limitations

1. Nonetheless, according to the Standard Model, a knowledge-based economy is a virtual contradiction in terms, an oxymoron. First, knowledge is treated as a *public good*, *i.e.*, it is non-

excludable (once ‘out there’, *e.g.*, published, one cannot easily be excluded from knowing). It is also non-rivalrous (your consumption does not reduce the quantity available to me). Excludability and rivalrousness are necessary assumptions of the Standard Model to internalize all costs and benefits in the market price. Accordingly, how can something be exchanged in a market, *i.e.*, bought and sold, if one cannot stop others from taking it for nothing and, if they do, one’s inventory is not thereby reduced? The answer is to create and use intellectual property rights like copyrights, patents, trademarks and registered industrial designs. Such rights, however, must be imposed by the State, thereby breaking one of the implicit tenets of the Standard Model – no government involvement in the economy.

2. Second, knowledge exhibits increasing returns, *i.e.*, if the quantity of capital and labour remain fixed but knowledge grows, output will increase continuously. New knowledge developed endogenously within a firm or nation through tinkering and refining the production process contributes as does new knowledge developed exogenously to both. Also, through increasing division and specialization of knowledge, suppliers improve the quality and/or reduce the price of inputs decreasing the cost of final output. The productive effects of this increasing division and specialization of knowledge is most apparent in what Marshall called ‘industrial districts’ (Marshall 1920, 271) or what today we call ‘clusters’ ([Martin and Sunley 1996, 282](#)). Put another way, knowledge feeds on knowledge.

3. As a factor of production, knowledge therefore contradicts two fundamental axioms of the Standard Model: (i) eventually diminishing marginal product, *i.e.*, if at least one factor is held constant then addition of a variable factor yields eventually diminishing marginal product, and, (ii) decreasing returns, *i.e.*, even if all factors are variable in the long-run, as the size of the firm increases eventually diminishing returns kick in due to crowding and congestion. Without these axioms, a deductively derived equilibrium price/quantity market relationship cannot be determined and therefore the profit maximizing position of a firm cannot be calculated. Furthermore, non-diminishing marginal product and increasing returns are incompatible with a perfectly competitive outcome leading instead to monopoly – the *bête noir* or ‘black beast’ of mainstream economic theory.

4. Third, technological change, generally recognized as the major contributor to economic growth and development over the last three or four centuries, is, in economic theory, the effect of any new knowledge on the production function of a firm or Nation-State. The nature and source of the knowledge is not a theoretical concern; only its effects on the production function. However, new knowledge has many sources and varying effects. It may be productive,

increasing output on the shop floor; it may be managerial, reducing cost or increasing sales; or, it may be entrepreneurial, realizing a vision of future markets, products and/or other opportunities. It may flow from the natural and engineering sciences (physical technology), the humanities and social sciences (organizational technology) or the Arts (design technology). In economic theory, however, it does not matter what form new knowledge takes; it does not matter from whence it comes; the only thing that matters, is its mathematical impact on the production function. With such a monotonic definition of technological change, how can one account for, let alone foster, the division and specialization of knowledge that characterizes a knowledge-based economy?

5. Fourth, in mainstream theory, knowledge is treated as an intermediate, not a final good in consumption. It is utilitarian, *i.e.*, it is an input into the production of final goods intended to satisfy human wants, needs and desires. Even if treated as a final good, however, knowledge is subject to the mainstream injunction: “De Gustibus Non Est Disputandum”, *i.e.*, taste is not disputable (Stigler & Becker 1977). Knowledge may, however, be non-utilitarian, valued in-and-of-itself satisfying the basic human need ‘to know’. Furthermore, knowledge, expressed as taste, is critical to consumer choice through product design and hence to competitiveness. As Marshall observed “increasingly it is the pattern that sells the thing” (Marshall 1920, 178). He also observed a close relationship between marketing and production, a relationship not formally recognized in mainstream economic thought even today (Marshall 1919, 181). If knowledge is treated simply as an input, how can one account for ‘style’ especially in consumer goods that constitute the bulk of economic activity?

6. Fifth, mainstream economic theory only admits knowledge generated through reason, specifically by calculation of benefit and cost, or what I call *calculatory rationalism*. Optimizing behaviour, *i.e.*, minimizing cost and maximizing output, relies on reason alone. Among other things, this ignores Adam Smith’s conviction about moral sentiments, *e.g.*, business trust and confidence. Such sentiments display significant cultural differences. In animistic Japan, for example, a business card is not just a card with a name but also a receptacle for the identity, spirit or soul of its name sake. To disrespect the card is to disrespect the person and no business will likely be done. Similarly, as noted by Adam Smith, the Spanish economy is Spanish and the British is British. Hence Spain has its unique siesta when businesses and shops close in the hot afternoon and re-open in the cool of the evening, sometimes until midnight. Without knowledge as trust, confidence and custom, how can there be a market? How is foreign trade possible?

7. Sixth, mainstream theory assumes producers and consumers possess symmetrical and/or perfect knowledge. In the case of risk, *i.e.*, uncertain knowledge about future states of the world, it is assumed expressible as a knowable probability function and it is resolved into options, *e.g.*, insurance (Loasby 2002). When economists assume asymmetrical knowledge, *i.e.*, when someone knows but others do not as in cases of insider trading, then problems of opportunism arise and mainstream theory crosses into game theory wherein ignorance can be cured but at the price of the Standard Model itself. Only a few economists have treated true uncertainty, *i.e.*, ignorance of future states of the world (Knight 1921; Keynes 1936; Hayek 1937; Shackle 1973, Loasby 2003). Ignorance is the opposite of knowledge, *i.e.*, the want of knowledge. To deal with true uncertainty, ignorance or surprise these few admit the ‘entrepreneur’ as possessing a non-rational form of knowledge – intuition or revelation – expressed by Keynes as ‘animal spirits’ (Keynes 1936, 161). Like some ancient priest-king, the entrepreneur ‘knows’ the future and leads his people (investors, managers, workers and consumers) into it – right or wrong - to success or failure. In a way, modern prophets seek profits. If, however, one assumes there is only certain (or probabilistic) knowledge, how can there be a market for new, *i.e.*, unknown knowledge? How can there be an entrepreneurial role different and distinct from that of an owner of capital, manager or worker?

2.3 Objective

1. In summary, the Standard Model treats knowledge as a probabilistically certain, culturally blind, monotonic, rational public good that enters the production function of a firm or Nation-State as an input. It does not, however, recognize knowledge as a final, highly differentiated output, *i.e.*, as an end in-and-of-itself. Even within this constrained framework, however, knowledge generates increasing returns and disruptive innovations incompatible with the perfectly competitive outcome. Thus, technically, with respect to knowledge at least, the Standard Model is a flawed ideology.

2. There is, however, also great disquiet around the world about an ideology that reduces human choice to atomistic calculation of profit and loss, not just in the marketplace, but in all human activities ranging from marriage and child rearing to art, education and culture. It is an ideology framed by the ‘X’ of intersecting market supply and demand curves marking the spot where human happiness is to be found.

3. Before the Republican Revolution, the economy was embedded in society through guilds and a class structure of subordination by birth. Today, some fear that human society is

being embedded into a global economy in which everything is for sale – hearts, kidneys, lungs as well as the entire natural and human built environment – as Karl Polanyi suggested in *The Great Transformation* (2001). Such lingering concerns may be genetic fragments of a not quite dead Marxism or remembrances of forgotten roots – equality, fraternity and liberty. In a way, the Republican Revolution sought political freedom for the individual and in the process spawned the free self-regulating market as its economic corollary. The Communist Revolution, on the other hand, sought economic freedom for the individual (each according to one’s need) through a centrally controlled command economy and spawned the one-party Leninist state as its political corollary. Arguably both forms of freedom – political and economic - are required to realize human potential.

4. It was not, and is not, however, just the far Left that has concerns about Bentham’s *felicitous calculus* and the Standard Model. Joseph Schumpeter called it “the shallowest of all conceivable philosophies of life that stands indeed in a position of irreconcilable antagonism to the rest of them” (Schumpeter 1954, 133). John Maynard Keynes went further identifying its dangerous ideological flaws:

I do now regard that as the worm which has been gnawing at the insides of modern civilization and is responsible for its present moral decay. We used to regard the Christians as the enemy, because they appeared as the representatives of tradition, convention and hocus-pocus. In truth, it was the Benthamite calculus, based on an over-valuation of the economic criterion, which was destroying the quality of the popular Ideal. Moreover, it was this escape from Bentham, ... which has served to protect the whole lot of us from the final *reductio ad absurdum* of Benthamism known as Marxism. (Keynes 1949, 96-7)

5. In effect every subsequent generation of economists has attempted to distance itself from the pernicious influences of Bentham and his hedonics. Thus “what is more important for the structure and scope of modern economics is the neutralising of utility in the ‘flight from psychology’, which resulted in the formal treatment of both rationality and equilibrium as internal consistency” (Giocoli 2003). There are, however, two significant implications to this flight. First, without a psychological foundation there is, in effect, no economic epistemology, no economic theory of knowledge. And if there is no economic epistemology, there can be no knowledge-based economy. Various attempts have been made to solve this problem including von Hayeks’ *The Sensory Order* (Hayek 1952) as well as insights of new sub-disciplines such as behavioural, cognitive, evolutionary and experimental economics as well as game theory and industrial dynamics. Second, without the utile reification of happiness into the presence or absence of money is not possible. Arguably one of the strength of the Standard Model is that

reification brings economics out of the clouds down into the pocketbook and wallet of the individual consumer.

6. Due in part to the technical and moral inadequacies of the Standard Model, public policy debate about the knowledge-based economy, at least to this and some other observers (Cowan, David & Foray 2000), exhibits a ‘thinness’ of content and context. My purpose is to deepen or ‘thicken’ this debate (Ryle 1968; Alder 1998, 503) and foster more effective national adaptation to the mutagenic environment of a knowledge-based economy where, quite simply, knowledge feeds on knowledge.

7. We are living through a second Cambrian Explosion (Kauffman 1995, 199) but this time of knowledge flowing from the scientific revolution beginning some 500 years ago. The resulting avalanche of knowledge about the natural world, and the associated human ability to manipulate it, has had a visible and very species specific outcome. In 1500 of the Common Era, three years before Leonardo Da Vinci began the *Mona Lisa*, some 400 million individuals lived, mostly from hand to mouth and a tsunami or epidemic away from extinction, in ten or so distinct civilizations spread out over five relatively isolated continental and sub-continental land masses (Durand 1977). Five hundred years or twenty-five generations later, a global self-regulating market economy of over 6 billion human beings is actively engaged in re-designing the ecology, geography and geology of all seven continents, harvesting the ocean depths, polluting the mountain peaks and encircling the globe with hundreds of artificial satellites plus one inhabited space station as well as probes to other planets and to the stars themselves, *e.g.*, Voyager I launched in 1977 is now in interstellar space (NASA 2003).

8. In this presentation I will explore the evolutionary economic impact of knowledge and in the process, hopefully, revivify economic epistemology (Parker 1993). Before doing so, however, I need to define the ideological posture from which my methodology flows.

9. I did my undergraduate and master’s program at Carleton University, Ottawa, Canada receiving a B.A. Hon. (1971) and M.A. (1974) in economics. I was heavily influenced by the work of Giles Paquet particularly in linking streams of economics thought including economic history and those of Kenneth Boulding with the French tradition of cultural anthropology, *e.g.*, Claude Levy Strauss and Lucien Levy Bruhl. It was, however, my B.A. Hon. advisor, Richard C. Vanderberg, who directed me towards American Institutionalism (Blaug 1996, 700-703). Vanderberg received his doctorate from the University of Wisconsin at Madison, arguably the home of American Institutionalism. He introduced me to the work of Thorstein Veblen, John R. Commons and W.C. Mitchell whose work fuelled my career as a ‘real world’ economist

considering the cultural (Veblen), legal (Commons) and statistical (Mitchell) nature of economic reality. Of American Institutionalism, Mark Blaug in his classic *Economic Theory in Retrospect* (1996) writes:

... no discussion of methodology in economics is complete without a mention of that greatest of all efforts to persuade economists to base their theories not on analogies from mechanics, but on analogies from biology and jurisprudence. (Blaug 1997, 700)

As will be seen, I continue and hopefully strengthen this tradition being one of the “few economists today who would consider themselves disciples of Veblen, Commons and Mitchell” (Blaug 1997, 703). To my list of masters I must add the Canadian economic historian and communications theorist, Harold Innis who, together with Schumpeter, can arguably be considered members of an Institutionalism much wider than ‘American’.

10. Since graduation, however, I have worked mainly in public finance and in an obscure and only recently recognized sub-discipline, Cultural Economics. Classified as category ‘Z000’ by the American Economics Association, the ‘zoo’ engages the economics of the arts, religion, social norms and economic anthropology. Following Kenneth Boulding’s seminal article “Towards a Cultural Economics” (Boulding 1972), I practice what amounts to interdisciplinary study within economics itself, weaving together findings from agricultural economics, industrial organization, institutional economics, labour economics, legal economics, micro- and macro-economics and public finance, among others, as they relate to the Arts and culture generally. My ideological bottom line is that maximizing, *i.e.*, economic, behaviour takes place within the context of culture and law. If you do not account for culture, you end up in the cannibal’s cooking pot; if you do not account for law, you end up in jail. Neither is a maximizing outcome.

11. The fact that a sub-discipline concerning culture and economics was not formally recognized until the early 1990s reflects, I believe, the effect of the great schism in Western economics. By the mid- to late-19th century, economics had formally split into two opposing camps, each serving as the base for an ideological program and reflecting, among other things:

- conflicting theories concerning the impact of culture or stage of cultural development on economic behaviour - yes for Marxists, no for the mainstream;
- conflicting theories of value, specifically whether labour was the only productive factor as Marxists believed or, whether capital was the most productive as the mainstream contended;

- conflicting beliefs in the efficacy of collectivist solutions to political economic problems such as the role of the Party as revolutionary vanguard and the dictatorship of the proletariat versus individualist solutions such as pluralistic democracy and the market mechanism; and,
- conflicting theories about the legitimacy of private property deemed exploitive by the Marxists and essential by the mainstream.

12. It is ironic that it is only the sanctity of private property that separates Bentham from Marx (Keynes 1949, 96-7). According to Marshall (1920, 628, ft 2), it was the terror of the French Revolution that stopped Bentham from embracing public ownership of all means of production and consumption. For Marx, revolution was, of course, the means to achieve that very end. In a sense, Marx was the son Bentham never had. It is also ironic that the end point, the *point omega*, of the Standard Model is perfect competition in which no one exercises market power, all costs are internalized in market price, all benefits are captured by the consumer and there is therefore no role for the State: the same outcome as under perfect communism with the Marxian withering away of the State.

13. The schism is also, to my mind, the reason why the philosophy of technology did not become formally organized as the Society for Philosophy and Technology until 1983 (Idhe 1991, 4). Arguably, Marxism is a philosophy of technology with its emphasis on the technological imperative. Quite simply, as with culture, it was not politically correct in the Anglosphere to make it the subject of formal academic study. As pointed out by Idhe, however, in western Europe significant strides were made after Marx with respect to the philosophy of technology (1991). Resolution of this schism is a subsidiary objective of my presentation.

3.0 METHODOLOGY: TRANS-DISCIPLINARY INDUCTION

1. Methodology is the organized means by which knowledge about something is acquired. That ‘something’ may be the subatomic foundation of a chemical reaction, intellectual property rights among Fourth World peoples, altered states of consciousness, the history of the automobile, echoes of the Big Bang, or the meaning of truth, love, beauty, destiny or justice.
2. The organized means to know about something varies according to the object under investigation as do disciplinary rules of evidence and instruments for its collection. When that ‘something’ is knowledge itself, however, one faces a meta-methodological dilemma. Understanding a system or thing requires a perspective higher than or conceptually above the object under investigation (Loasby 1971, 863). How can one attain a position that transcends knowledge? How can one know all its domains and forms or all the faculties for its acquisition? Such questions border on metaphysics, itself, of course, a discipline of thought.
3. Given the inadequacies of the Standard Model and the thinness of public policy debate concerning the knowledge-based economy, a methodology is required to reach out beyond the disciplinary frontiers of economics to collect, compile and collate ‘knowledge about knowledge’. My solution was ‘Trans-Disciplinary Induction’ or TDI, which was used to harvest knowledge about knowledge from the event horizons of five disciplines of thought and interdisciplinary fields of study including economics, philosophy, psychology and two ‘interdisciplinary’ fields of study - science and technology - and seventeen of their sub-disciplines plus etymology, *i.e.*, the origin and meaning of words (Exhibit 1).
4. I will now define TDI and outline its weaknesses and strengths. I will then, in the following four chapters, report my findings as increasingly detailed definition of knowledge as noun, verb, form and content. In the remaining chapters I will examine the nature of the Nation-State and consider the competitiveness of nations in a global knowledge-based economy.

Exhibit 1
Trans-Disciplinary Event Horizon

Discipline/ Sub-discipline	Economics	Philosophy	Psychology	Science	Technology
1	Cultural	Aesthetics	Analytic	Economics	Economics
2	Institutional	Biology	Cognitive	History	History
3	Legal	Epistemology	Gestalt	Philosophy	Philosophy
4	...	Phenomenology	...	Sociology	...

3.1 Trans –

1. I begin with the prefix ‘trans’ which derives from the Latin meaning “across, to or on the farther side of, beyond, over”. In biochemistry and biology, it has the additional meaning of ‘transfer’, *e.g.*, of genes across species, *i.e.*, trans-genetic (OED, *trans-*, prefix, 10. Biochem. and Biol.). In addition, as an adjective, trans- conveys the sense of ‘beyond, surpassing, transcending’, as in trans-human. I use the word in the sense of transferring ‘knowledge about knowledge’ across disciplines in the hope of attaining a transcendent understanding or overview of knowledge.

2. Trans-, however, must be contrasted with ‘inter-’ as in Jean Piaget’s 1973 *Main Trends in Inter-Disciplinary Research*. ‘Inter-’ too is a prefix deriving from the Latin but meaning “between, among, amid, in between, in the midst” (OED, *inter-*, prefix, etymology). In this sense, inter-disciplinary means standing between disciplines and sharing, not transcending, their observations and findings. Piaget also restricts inter-disciplinary studies to the natural & engineering sciences with but a concluding extension to the ‘human sciences’. He thereby excludes the Arts and the humanities. Furthermore, his analysis is rooted in the ‘positivist’ tradition of Logical Empiricism in which empiricism is defined in linguistic terms as the common rules of grammar, vocabulary and syntax used by different disciplines to ‘prove’ their findings. This excludes, of course, non-linguistic, non-codifiable forms of knowledge such as the aesthetic experience, which disappears under analysis. It also ignores what David Baird calls ‘thing knowledge’ (Baird 2004) or what I will call ‘tooled knowledge’, *i.e.*, knowing through the existential phenomenological extension of our physical selves using sensors, tools and toys.

3.2 Disciplinary

1. The word ‘discipline’ derives from the Old French meaning “instruction of disciples”. Discipline is concerned with the practice or exercise of a disciple in contrast to ‘doctrine’ which is “the property of the doctor or teacher” who is concerned with abstract theory or dogma (OED, *discipline*, etymology). Put another way, discipline concerns what is practiced and doctrine concerns what is taught and thought, *i.e.*, a body or system of principles or tenets. How it is taught is pedagogy, *i.e.*, “the art or science of teaching” (OED, *pedagogy*, 1).

2. For my immediate purposes, discipline will be defined as “a department of learning or knowledge; a science or art in its educational aspect” (OED, *discipline*, n, 2). Such departments tend to be institutional, not just abstract. Since Plato’s Academy they have also been reified as organizational and physical structures.

3. Now, as then, entry and exit is controlled, initiates supervised and doctrine regulated. Once admitted, initiates rise up the hierarchy first teaching what once they were taught and then administering the organization and/or adding to the body or interpretation of doctrine. This corresponds to: “the system or method by which order is maintained in a church, and control exercised over the conduct of its members; the procedure whereby this is carried out; the exercise of the power of censure, admonition, excommunication, or other penal measures” (OED, *discipline*, n, 6a). Put another way, the organization of disciplinary knowledge is, by definition, institutional, with barriers to entry erected to screen admission and then supervise training, qualification and practice.

4. Disciplinary practice in the Church took the form of doctrinaire monastic orders – Benedictine, Cistercian, Gregorian, Franciscans, Jesuit, *etc.* (Cantor 1969). This changed with the arrival of the self-governing university, independent of Church and State, during the twelfth and thirteenth centuries of the Common Era (C.E.). At its beginnings, the university was an incorporated association of teachers, as in Paris, or of students, as in Bologna (Schumpeter 1954, 77-78). Oxford University, the first English university, founded in 1167 C.E., was modeled on the University of Paris. The university broke the monopoly of knowledge held by the Church and its monasteries. The universities quickly assembled libraries of their own including works not approved by the Church. Secular monarchs granted the universities charters defining their rights, freedoms and obligations to the Crown (similar to other guilds) and then cultivated and supported them not just for the sake of knowledge but as a source of talent to balance the influence of the Church.

5. The medieval university was typically organized into three primary domains of philosophy (literally ‘the love of knowledge’): natural, moral and metaphysical. To these, the practices (applied knowledge) or self-regulating professions of law and medicine were added as distinct, quasi-independent branches of learning. Excepting the practices, the university taught the ‘Liberal Arts’, *i.e.*, knowledge suitable for the edification of gentlemen and nobles. This included music, the only Art originally admitted to the university.

6. University departments were paralleled in the ‘real world’ by guilds each of which practiced a distinct ‘mystery’ (Houghton 1941) of the Mechanical Arts. To work with the mind and the word was noble; to work with the hands, however, was considered ignoble and demeaning. Arguably, this bifurcation of ‘knowledge-for-knowledge’s-sake’ and ‘knowledge-for-practice’ is evidenced in contemporary distinctions between science and technology and between management and labour.

7. With respect to modern disciplines, natural philosophy broke out into the natural & engineering sciences while moral philosophy split into the humanities & social sciences. Nonetheless, the organizational structure and rituals of the medieval university continue to this day. Anachronisms include: the Bachelor & Master of Arts and Doctor of Philosophy degrees; the robes; and, the positions such as chancellor, dean, provost, *etc.* The word ‘anachronism’ highlights a salient characteristic of knowledge, *i.e.*, it exists in overlapping “temporal gestalten” (Emery & Trist 1972, 24) or ‘epistemes’ (Foucault 1973). In effect, the Present is woven out of uneven temporal strands, *e.g.*, of religion, politics, language, *etc.*, each stretching ontologically back into the Past. In this sense Time’s Arrow runs both backwards and forwards in the noösphere. Such a view contradicts the concept of ‘modernity’ as the homogenous co-temporality of all sectors of society.

8. Picture a graduating PhD on stage receiving a diploma in 21st century genomics wearing robes designed in the 12th or 13th centuries and a mortar board, square or trencher cap from 17th century Oxford and Cambridge (Australian University Women, *Academic Dress Hire Service*, 2004). The knowledge in the ritual and that embodied in the diploma are from different historical periods overlapping as the graduate’s present - a re-linking with the past, a *re-ligio*. Unlike the natural & engineering science where new knowledge displaces the old, in other domains the old often continues to be relevant, *e.g.*, while ancient Greek physics is not taught in the modern university, ancient Greek philosophy continues as part of the curriculum; Bach, Shakespeare and Sophocles continue to ‘speak’ to audiences.

9. As pointed out by Foucault (1973) different periods of history are characterized by different dominant strains or patterns of thought or *epistemes*, including the history of science. Idhe (1991) compares Foucault’s *epistemes* to Kuhn’s ‘paradigms’ that define ‘normal science’ in non-revolutionary times (Kuhn 1996). *Epistemes* are artifacts of another age that continue to function in the contemporary world. Thus the Scholastic Period of western thought was rooted in analogy, *i.e.*, if it looks like a duck and quacks like a duck then it must be a duck! While reduced in stature by the experimental method, knowing by analogy continues to operate in the natural & engineering sciences and throughout the rest of society. Like old philosophies, *epistemes* tend to persist. A shift from one paradigm to another in the natural & engineering is accompanied by a loss of some previous knowledge known as a Kuhnian loss (Fuller 2000). In other knowledge domains, however, while a change in *epistemes* results in the loss of some previous understanding, it tends to be smaller and less definitive. In fact, old *epistemes* continue, underground, contributing to the “overlapping temporal gestalten” identified by Emery & Trist as characterizing the Present (Emery & Trist 1972, 24).

10. What differentiates modern disciplines from medieval ones, however, is emphasis on *additions to* rather than *interpretation of* existing knowledge. This change became embodied in the ‘research university’ which appeared first at the University of Berlin in 1809 and then spread to the United States and beyond. Emphasis on ‘new’ knowledge led to a progressive fissioning of the natural and engineering sciences into an ever increasing array of sub-disciplines and specialties (Kuhn 1996). Each has its own differentiated theory, language, practices, instruments, research agenda and talent. Each tends to bifurcate into theoretical and practical branches, *e.g.*, economic theory vs. economic policy. Furthermore, the taxonomic structure of many disciplines in the humanities and social sciences is culturally determined, *e.g.*, the French university syllabus in sociology is different from the British and that from the American.

11. This process of the splitting off (the Latin meaning of ‘science’) is an example of the division and specialization of knowledge in action. It has the benefit of ever more detailed examination of a phenomenon but at the cost of increasing incommensurability, *i.e.*, the inability to communicate knowledge to the uninitiated. It also has the associated costs of resistance to heterodox approaches and external audit, *e.g.*, inter-disciplinary studies. In a manner of speaking, what is gained in depth and detail is lost in breadth of vision.

3.3 Induction

1. In logic, induction refers to reasoning from the specific to the general in contrast to deduction which refers to reasoning from the general to the specific. The word ‘induction’ derives from the French meaning “the action of introducing to, or initiating in, the knowledge of something” (OED, *induction*, 2). It is in this sense that trans-disciplinary induction involves introducing, in my case, economics, to arguments and evidence from other disciplines of thought.

2. If induction carries the sense of increase, then deduction carries the sense of decrease. In fact, the word ‘deduction’ derives from the French meaning “the action of deducting” (OED, *deduction*, 1a). Put another way, deduction involves simplification of the complex; induction involves the complication of the simple, in this case, the word ‘knowledge’. Deduction serves as the basis of reductionism in the natural and engineering sciences as well as in the social sciences practicing ‘calculatory rationalism’.

3. Trans-disciplinary induction can be expressed in three complimentary ways. First, as in semiotics and analytic psychology, knowledge about a given phenomenon - in this case about knowledge – can be seen symbolically. In effect, trans-disciplinary induction involves a

circumambulation around the question looking at it from as many different perspectives as possible and interpreting specific disciplinary findings as symbolic of a wider, more numinous meaning (Neumann 1954, 7).

4. Second, as in astronomy, a discipline can be likened to a black hole of complexity into which relevant evidence and argument flow over an event horizon. Once inside that horizon knowledge and information about what goes on therein become, as will be seen in greater detail below, relatively inaccessible to outsiders due to paradigmatic incommensurability (Kuhn 1996). Using this metaphor, trans-disciplinary induction tries to capture, cream off, harvest or otherwise pick off ‘knowledge about knowledge’ from the event horizon before it is sucked into the black hole where it becomes enmeshed in often heated and complex internalist debate specific to a discipline and relatively meaningless to outsiders, *e.g.*, the economics of Keynes vs. Keynesian Economics.

5. Once upon a time, one could become a ‘Renaissance Man’ or a polymath. The quantity of human knowledge was relatively small. Since that time, however, there has been a knowledge explosion comparable to the Cambrian explosion of life, so-called because of the relatively short geological period over which the vast diversity of multi-cell and multi-organ life forms appeared on earth. Recent innovations in knowledge and information technology may now once again make it possible to at least survey the full spectrum of human knowledge, but from outside the disciplinary black hole. To a degree, this skimming of the event horizons of multiple disciplines is possible because of new web-based research libraries and tools such as JSTOR at the University of Chicago. These systems permit, for example, key word searches of most major academic journals in many disciplines. In the case of JSTOR coverage is from the late 1800s to five years before the moving present time. This historical depth facilitates ‘intellectual archaeology’.

6. Third, as in molecular biology or genomics, TDI can be compared with Kauffman’s patchwork procedure:

The basic idea of the patch procedure is simple: take a hard, conflict-laden task in which many parts interact, and divide it into a quilt of nonoverlapping patches. Try to optimize within each patch. As this occurs, the couplings between parts in two patches across patch boundaries will mean that finding a “good” solution in one patch will change the problem to be solved by the part in the adjacent patches. Since changes in each patch will alter the problems confronted by the neighboring patches, and the adaptive moves by those patches in turn will alter the problem faced by yet other patches, the system is just like our model coevolving ecosystems... We are about to see that if the entire conflict-laden task is broken into the properly chosen patches, the coevolving system lies at a phase transition between order and

chaos and rapidly finds very good solutions. Patches, in short, may be a fundamental process we have evolved in our social systems, and perhaps elsewhere, to solve very hard problems. (Kauffman 1995, 252-253)

7. Each of the sub-disciplines surveyed can be likened to a patch. A solution suggested in one may aid resolution of questions not only in another discipline, *i.e.*, inter-disciplinary, but also systemically, *i.e.*, trans-disciplinary or ideologically. Kauffman's patchwork method is reminiscent of multiple equilibria analysis in the theory of economic development. An equilibrium is a point of stability towards which an economy will return after short-run shocks to the system. There are, however, many possible equilibria only one of which is optimal leading to long-term growth. The others are sub-optimal solutions leading, in the long-run, to stagnation or worse. In economics, there is no mechanism to ensure that the optimal equilibrium is attained. In molecular biology, however, systemic optimality is assured through the patchwork induction of local solutions. I can but hope that TDI provides some optimality concerning 'knowledge about knowledge'.

8. TDI, in effect, redefines 'ideology' as the search for commensurable sets or systems of ideas (in this case about knowledge) shared across different knowledge domains, practices, disciplines, sub-disciplines and specialities of thought. Given the increasing incommensurability of knowledge within and between knowledge domains finding such shared or common conceptual structures should facilitate communication and permit us "to glimpse a *constructivist* companion to the reductionist thesis" (Kauffman 2000, 268).

3.4 Weaknesses & Strengths

1. Like any methodology, TDI has strengths and weaknesses. Its strengths include the breadth of vision it contributes to meta-methodological problems like truth, justice and poverty. It also can reveal commonalities or isomorphisms between disciplines of thought revealing, perhaps, the essence of the phenomenon under investigation, *i.e.*, "that which constitutes the being of a thing" (OED, *essence*, n, 7). To the degree that such phenomena are ideas, then to that degree TDI arguably constitutes ideology, *i.e.* a science of ideas (OED, *ideology*, 1a),

2. Its weaknesses, however, are many. First, it relies on language, which can articulate some but not all forms of knowledge. This includes so-called 'tacit' knowledge that, by definition, is not, or cannot, be codified (M. Polanyi 1962a). All linguistic-based methodologies have similar difficulties in treating non-linguistic forms of knowledge such as the aesthetic experience, "technological intelligence" (Aldrich 1969, 381), 'instrumental realism' (Idhe 1991) and 'instrumental epistemology' (Baird 2004).

3. This limitation of language finds two specific expressions in this dissertation. The first is the language of the dissertation itself – English. Knowledge, in English, is, in fact, an etymological monad. Thus one verb, ‘to know’, veils four distinct meanings: to know by the senses, by the mind, by doing and by experience. In German, by contrast, there are four separate and distinct verbs to express each of these meanings.
4. The second problem involves disciplines and sub-disciplines that use words with specific ‘disciplinary’ or ‘technical’ meaning. Such meanings sometimes differ between disciplines. More often, however, disciplinary usage differs from ‘common sense’ usage. Given seventeen sub-disciplines are engaged, extensive, and to some readers disconcerting, use is made of common sense definitions generally drawn from the *Oxford English Dictionary* (OED 2005). Consider the term ‘utility’. In common use it means “the fact, character, or quality of being useful or serviceable” (OED *utility*, n, 1a). In economics, however, utility, means the number of ‘utiles’ – a unit measure of pleasure/pain - carried by a good or service. Utility is extracted by the consumer to gain satisfaction or happiness expressed in the *felicitous calculus* of Jeremy Bentham. Accordingly, except where otherwise noted, words are used in their common sense or dictionary meaning throughout the text.
5. Second, TDI is akin to sophistry: one builds the strongest case from supporting evidence and argument, ignoring, deflecting but seldom directly confronting or refuting contrary evidence. TDI is therefore inherently subjective and dependent on the experience, skill and ethics of its practitioner.
6. Third, TDI, like medieval scholasticism, relies on authority. While evidence is gathered from experts, their contributions are generally subject to dispute and debate internal to their own respective disciplines. Such controversies are generally ignored when using TDI. Furthermore, one gathers such evidence using one’s own external or outsider’s reading, *i.e.*, seeing with one’s own optic (Loasby 1967, 172-173).
7. Fourth, each TDI researcher is inevitably strong in some fields while weak in others. True polymaths are probably extinct. Experimenter expectation or bias can therefore be expected. But as Kuhn suggests, even the choice of normal science puzzles is biased by a scientist’s culture, experience and language (Kuhn 1996, 128). To this degree, even the natural & engineering sciences are value-laden.
8. For all its weaknesses, TDI is, to paraphrase Kenneth Boulding: “better than nothing” (Boulding 1966, 3). Furthermore, TDI admits that “there is an incompatibility between precision

and complexity. As the complexity of a system increases, our ability to make precise and yet non-trivial assertions about its behavior diminishes” (Zadeh 1987, 23).

9.0 In summary, given the epistemological and moral inadequacies of the Standard Model in economics and the thinness of public policy debate concerning the knowledge-based economy, a methodology was required to reach out beyond the disciplinary frontiers of economics to collect, compile and collate ‘knowledge about knowledge’. This methodology is called trans-disciplinary induction or TDI. I will now present my TDI findings in the following four chapters using Kauffman’s metaphor of an avalanche in the guise of four increasingly detailed definitions of knowledge as noun, verb, form and content. Having defined knowledge I will then examine the nature of the Nation-State and determine the competitiveness of nations in a global knowledge-based economy.

4.0 KNOWLEDGE AS NOUN

1. I now begin progressively deeper and denser definition of knowledge. I start with knowledge as a ‘monotonic noun’. I will treat it as an abstract Platonic noun like Beauty, Love, Truth, Justice, *etc.* I will first explain what I mean by ‘monotonic’ and ‘noun’. I will then demonstrate why this characterization is appropriate by reference to the undifferentiated but polymorphous biological human need to know, the immeasurability and incommensurability of knowledge and its general expression through inherently limited and biased human language including mathematics and English. In effect, I will argue that the elemental biological human need to know is, in Aristotelian terms, the material cause of knowledge.

4.1 Monotone

1. A monotone is, in music, “a single unvaried tone, or a succession of sounds at the same pitch (Grove Music Online 2005). Music, of course, appeals to one of the two ‘distant’ human senses for knowing – hearing; the other being sight. Music may be guided by reason in composition but in appreciation, a term distinguishing aesthetic from intellectual knowledge, is through emotion, sentiment or what Jung calls ‘feeling’ ([Sharp 1991](#)). Aesthetic feeling distances one in contemplation as opposed to overwhelming one through the immediacy of sensation received through the ‘contact’ senses of touch, taste and smell. The first is ‘sensuous’ and the later, ‘sensual’ knowing ([Berleant 1964](#)). Interestingly, Joseph Henderson includes this aesthetic sense among four primary psycho-cultural attitudes - social, religious, aesthetic and philosophic – and concludes: “we cannot claim for science... the same epistemological authenticity that we can demonstrate in the four basic cultural attitudes” ([Henderson 1984](#), 77).

2. In a way, music was the first experimental science. Thus Pythagoras (about 530 B.C.E.), using the strings of musical instruments, revealed an audible, measurable, cognate relationship between number and matter. Arguably this is one of the most important bits of ‘knowledge’ inherited from the Ancient World. It should also be recalled that the connexion between music and mathematics and hence Nature was recognized by inclusion of music among the Liberal Arts in ancient times and within the Western university from its medieval beginnings. As will be seen in greater detail below, the other performing arts disciplines – dance and theatre – as well as the visual arts were not admitted to the university until the 20th century.

3. Using his findings, Pythagoras constructed what was the first Western model of knowledge - his four-fold *Tetraktys* (Apatow 1999). This begins with a monotone of the undivided string, or monad *i.e.*, an indivisible unit of being (OED, *monad*, n & a, 2a). The term, however, carries philosophical and metaphysical baggage accumulated over time by Pythagoras, Plato, Aristotle, Synesius, Bruno, Spinoza and especially Leibnitz, co-discoverer of calculus (Catholic Encyclopedia, *Monad*, 1997).

4. As with all disciplines of thought, philosophy has engaged in heated intra-disciplinary debate over the meaning of the term. For my purposes I take its original Pythagorean event horizon “as the name of the unity from which, as from a principle (*arche*), all number and multiplicity are derived” (Catholic Encyclopedia, *Monad*, 1997). Extending this musical motif, I will subsequently present knowledge as diaphonic, triaphonic and quadraphonic (speaking in two, three and four voices, respectively).

5. The monotone as “a succession of sounds at the same pitch” (Grove Music Online 2005), however, also introduces another characteristic of knowledge – Time. Other than observing the changing seasons and stars, the first human-made time piece was music. Musical rhythms serve to organize or pace human activity in dance and celebration and also at work and in war. It is no coincidence that the military band budget for the USA armed forces was over \$100 million in 2004 while the National Endowment for the Arts – responsible for support of all artistic disciplines across America – was only \$121 million (NEA 2004).

6. In this regard, Marjorie Grene (1957), arguably the mother of the modern philosophy of biology, points out that one of Heidegger’s greatest contributions to philosophy was explication of the connection between being and time. Specifically, human thought (and therefore knowledge) operates only in Time, not in Space: “It is only with *objects* that space re-enters the picture” (Grene 1957, 66). Arguably, this observation finds expression in Grene’s later work as the concept of reflective privacy:

Members of our species are able not only to plan what they want to do in specific circumstances, by cooperating with others or scheming against them, but have the ability to think about their own thoughts in reflective privacy. (Grene & Depew 2004, 336)

7. Movement along and across timelines is alternatively called memory, planning, intentionality or imagination of spaces, places and times without leaving the comfort of one’s own head. The uni-dimensionality of thought with Space folded up into Time produces, perhaps, what Descartes called ‘the ghost in the machine’ or our sense of the ethereal, spiritual or transcendental. In fact,

to account for the ordered experience we actually do have, we must presuppose a power of the mind to make it ordered: not, however, a power of abstract thought simply, but of imagination. It is the faculty which Kant calls ‘productive imagination’ that effects this all-important mediation; and it does so, again, in reference to the temporal relations from which the argument began. (Greene 1957, 64)

8. At the level the noosphere itself, Time is also fundamentally different from scientific or physical time, *i.e.*, Time’s Arrow does not just move forward, but also backwards and sideways in human thought. The implications of Time for the noosphere will be more fully examined below when I consider Emery & Trist’s overlapping temporal gestalten (Emery & Trist 1972, 24), Foucault’s epistemes (Foucault, 1973), and, Thomas Shales’ Re-Decade (Shales 1986). For my immediate purposes, however, it is sufficient to say that knowledge exists like a focal monadic ‘I know’ at a moment of Time but nowhere in Space. This, of course, ignores the neurophysiologic bases of thought but, as will be seen, consideration of this subsidiary base will cause the focal thought to be lost.

4.2 Noun

1. A noun is “a word used as the name or designation of a person, place, or thing; the class or category of such words” (OED, *noun*, n, 1). There are, therefore, different classes of nouns, *e.g.*, proper nouns. For my purposes, knowledge begins as a Platonic abstract or idealized noun like Beauty, Love, Truth, Justice, *etc.* In effect, a Platonic noun describes an abstract concept that exists independent of any name it may be given. As will be seen, such nouns do not exist in all human languages. Where they do, however, they have an ‘awe’ factor, or what in analytic psychology is called ‘numinosity’ (Sharp 1991), hence the attraction of expressions such as ‘knowledge-based economy’.

4.3 Biology

1. According to William James, arguably the first Darwinian psychologist, “unless consciousness served some useful purpose, it would not have been superadded to life” (quoted by Greene & Depew 2004, 337). Arguably, the useful purpose is that “all knowledge is orientation” for “finding one’s way in an environment” (Greene & Depew 2004, 349 & 354).

2. Every organism perceives, *i.e.*, has sensory knowledge or perception of: (a) an active environment in which it must make a living or die; (b) information about invariants in that environment that enframe it; and, (c) “affordances”, *i.e.*, opportunities and/or dangers presented by it (Greene & Depew 2004, 347). Like Kauffman’s bacterium swimming upstream towards a

glucose flow (Kauffman 2000, 7), all organisms have a purpose, have the intention of surviving and reproducing. This is what Kant called ‘natural purpose’ for which no divine intervention is required because life flows, according to Kauffman, naturally from chemistry, that is, “as the molecular diversity of a reaction system increases, a critical threshold is reached at which collectively autocatalytic, self-reproducing chemical reaction networks emerge spontaneously” (2000, 16). For Kauffman, the implication is that life in the universe is “abundant, emergent, expected” (2000, 16). In his observations he also hints at a fourth law of thermodynamics: “a tendency for self-constructing biospheres to enlarge their workspace, the dimensionality of their adjacent possible, perhaps as fast, on average, as is possible ...” (Kauffman 2000, 244).

3. If all knowledge is orientation in an environment then two questions arise. First, what is the nature of the organism? And second, what is the nature of its environment?

4. In this case, the organism is humanity, a most peculiar beast for a number of reasons. First, unlike other species for which the nearest relative is usually another living species, “the nearest *living* relative of *H. sapiens*, the chimpanzee, is phylogenetically very distant from us” (Greene & Depew, 2004, 327). Our closer relatives apparently succumbed, beginning about 250,000 years ago, to climate change and to our adaptive success achieved through “cooperation, communication, and cleverness” (Greene & Depew, 2004, 327). Put crudely, we cannot find the missing link because we ate him! This leaves “as Blumenbach had long ago suggested, an enormous hole in the phylogenetic continuum” (Greene & Depew 2004, 329). This gap may have resulted because for our species:

Conceptual thought and language constitute, in effect, a new way of transmitting information from one generation to the next. This cultural inheritance does the same thing for man that in the subhuman world is done by the genetic system... This means that, besides his biological system, man has a completely new ‘genetic’ system dependent on cultural transmission. (Waddington 1960, 148-149)

5. Second, unlike almost all other mammals, human beings exhibit “sexual availability and eagerness at every season” (Greene & Depew 2004, 325). This has a number of implications. On the one hand this means that carnal knowledge or sexual pleasure seeking can and often is separated from reproduction. The result is a Sex Industry that has been, is now and likely will always be. It is part of a wider Pleasure Industry of which more below. In this regard, it should not be surprising that the Sex Industry is one of the prime ‘first adopters’ of new communications technology such as videotape, DVDs and the Internet. On the other hand,

Whereas in other species ... the relation between the sexes for the sake of reproduction is specified and particularly adaptive, in the case of humans we should find no determined and species-specific mode of relationship, but

rather generalized features from which it is necessary to define specific modes... [This means that] an individual has little advanced information that will help him coexist with others on a predictable basis... If the human individual is to coexist with other such individuals, he must arrive at some ground for expectation and reciprocation. He must work out some common form of agreement about actions and reactions. (Wilson 1980, 43)

Definition of such “specific modes” of sexual relations is achieved through culture (“some common form of agreement”) rather than Nature. The current clash between religious fundamentalism (Christian, Hindu, Islamic, Jewish, *etc.*) and secular society centres on the status of women – unequal, equal or separate but equal. The first and the third reflect traditional ‘sexual apartheid’. The second reflects Western secularism.

6. Coevolution refers to reciprocal evolutionary change in interacting species. For my purposes, it refers to our adaptive success resulting from the coevolution of culture embodied in what Carl Sagan (1977) called extra-somatic knowledge, or what I call codified and tooled knowledge, *versus* somatic knowledge contained in our genes, *e.g.*, instincts. It constitutes a completely new ‘genetic system’ (Waddington 1960, 149). This is but a dynamic variation on the theme of nurture and nature but a variation in which cultural nurture (extra-somatic knowledge) mediates behavioural nature, *e.g.*, from hunter gatherer to farmer to industrial to knowledge worker. While some believe we are genetically adapted only to a hunter-gatherer Pleistocene environment, this is not the relevant timescale. As Edgar Zilsel put it, to think:

that the biological rise of mammals during the tertiary period and the political rise of Germany since 1933 belong to one line of evolution is the same as to consider the transition from winter to summer a continuation of the dying away of the glacial period. (Zilsel 1940a, 121-122)

7. As will be demonstrated in greater detail below, humanity, like other organisms, adjusts to its environment but it also adjusts the environment to itself. In effect, following the Scientific Revolution, and especially in the last one hundred years, the human species has progressively enframed its own ecological fishbowl at the expense of all other ecologies on earth. Two measures demonstrate. First, nearly half of humanity now lives in cities. In the developed world, it is closer to eighty percent (Population Division, 2002). The city is the quintessential human built environment (Steiner 1976). Second, according to a 1994-95 time use study, Canadians spent “the majority of their time indoors (88.6%) with smaller proportions of time outdoors (6.1%) and in vehicles (5.3%) (Leech *et al* 1997). If one counts ‘a vehicle’ as a portable cave, then the average Canadian spends 94% of his or her life inside the human built environment. The cave dweller lives! Will space colonies be so different?

8. The environment for the human organism is thus increasingly human-made, human-populated and one for which:

Our minds are certainly adapted to deal ... by way of ideas... because the tie that binds us to the cultural world as agents, caregivers, competitors, speakers, and thinkers affords us direct (rather than representational) access to the environments in which we act responsively and, ultimately, responsibly. (Greene & Depew 2004, 339)

9. The interaction, or coevolution, of culture and genes can be seen in the shorter gestation time for human beings evidenced by the immature human neonate without hair and requiring child care and a host of other social supports. As Greene & Depew put it: “Many mutually interacting causes are at work here” (Greene & Depew 2004, 332). Such post-natal care amounts to a social womb which, like a marsupial’s pouch, allows the infant to further develop before entering the real world. Arguably, the length of this social womb has increased dramatically since introduction of compulsory education in the late 19th century. At that time primary or elementary education was sufficient before the human neonate was ready to enter the world of work. Then it became secondary and then tertiary education which, in the Anglosphere (Bennett 2000), is usually a university degree. With the introduction of ‘life long learning’ it can be argued that the social womb now stretches from birth to death and the human being never grows up, never leaves home.

10. Greene & Depew identify three forms of indirect perception unique to the human species. They are all cultural inventions: tools, language and pictures.

From birth, the perceptions of the infant, then of the child and of the adult are saturated by these human and cultural ingredients. But the fundamental structure of perception remains the foundation of these accomplishments... if not the foundation, at least the analogue, of all knowledge. (Greene & Depew 2004, 357-8)

While I agree, I classify them differently, specifically as codified and tooled knowledge. For my purposes, pictures constitute codified semiotic knowledge along with language while tooled knowledge is the physical technology with which the human species enframes and enables its environment thereby introducing more and more invariants into that environment.

11. Even in biology, however, ideology is to be found. While Conant was concerned about the ‘dirty hands’ of physicists and the atomic bomb, biologists are concerned about eugenics and its logical outcome, the Holocaust, as well as its application, until relatively recently, in liberal western democracies to the socially ‘unfit’. In reviewing evidence from the modern evolutionary synthesis, Greene & Depew conclude, quoting Beatty: “A diverse, panmictic

population, and the democratic beliefs necessary to sustain it, produce the most adapted, and adaptable, populations” (Greene & Depew 2004, 331).

12. In summary, human knowledge literally begins with the dawn of consciousness. It arrived in a phylogenetic instant of self-awareness with the appearance of our species *homo sapiens* (literally ‘the man that knows’) some 300,000 years ago and of our sub-species *homo sapiens sapiens* (the man that knows that he knows) about 20 to 30,000 years ago. Subsequently each of us experiences an individual ontogenetic instant, repeated generation after generation, when we emerge out of infancy into self-reflective consciousness. ‘To know’ is *the* defining characteristic of our species. But to know what is the pragmatic question? In a world of apparently ever increasing diversity and specialization ‘what’s to know’ is a big question for the individual and the Nation-State. This urge to know is polymorphous and undifferentiated. Put another way, it can lead to good or evil or neither.

13. Furthermore, in spite of cultural inventions permitting indirect perception, ultimately only the individual human being can ‘know’. Books, pictures and computers do not know that they know, nor does any other species, at least on this planet. Companies, corporations and governments or, in Common Law, ‘legal persons’, cannot know. Only the solitary flesh and blood ‘natural Person’ can know. Furthermore, being organic, knowledge mutates, selectively feeding on itself, growing and developing. Thus when two different streams of knowledge meet in a single individual they tend to interact, mutating into new knowledge or connexions.

4.4 Immeasurability

1. The immeasurability of knowledge can be demonstrated by the distinction between information and knowledge management (Bouthillier & Shearer 2002) or between ‘bits’ and ‘wits’ (Boulding 1966). Information theory involves storage and transmission of human knowledge in electronic rather than hardcopy or analogue format. These remain the domain of library science and the Dewey Decimal System. Electronic storage involves audio-video discs, tapes, databases, hard drives, e-books, *etc.* Transmission and reception requires hardware such as computers, radios, television sets and the Internet. ‘Analogue’ content is digitized for storage and transmission then reconverted into human-readable analogue format, *e.g.*, sounds, pictures and words. The unit of digitization is the binary on/off ‘bit’: (0, 1).

2. The ‘bit’, however, abstracts from the content of stored or transmitted information. The same number of bits could emerge from a telephone conversation between two teen-age girls in Saskatoon or between the Presidents of the United States and the Russian Federation. Bits don’t

discriminate. Developed for the world of telecommunications and computers, the bit lends itself to quantitative analysis. It does not, however, provide a homogenous unit of knowledge, or what Kenneth Boulding calls ‘the wit’ (Boulding 1966, 2). The bit also makes no allowance for ignorance, *i.e.*, the absence of knowledge. Without a wit, we are restricted to qualitative or descriptive analysis. Accordingly, in what follows no attempt is made to quantitatively ‘test’. The argument stands or falls on logic and believability. However, to again paraphrase Kenneth Boulding, “this is better than nothing” (Boulding 1966, 3).

3. Immeasurability has not, however, stopped economists, among others. The ‘utile’ – Jeremy Bentham’s unit measure of pleasure and pain – is the foundation stone of modern economic analysis. We cannot, however, measure the pleasure and pain of an individual, nor can we add it up across individuals using *felicitous calculus* to estimate ‘the greatest good for the greatest number’. The measurement problem is finessed through *reification by proxy*. That is, let us assume the utile can be reified, *i.e.*, made concrete and calculable, specifically as money. In this philosophy, one works (suffering disutility) to earn income to buy goods and services to consume them, *i.e.*, extract utility. The money price one pays on the market reflects the utility appropriated by the consumer. Some day the ‘wit’ too may be reified but at the moment there is no obvious proxy on the horizon.

4.5 Incommensurability

1. Beyond immeasurability, there is the incommensurability of knowledge. Incommensurable is an adjective meaning “having no ... common measure except unity” (OED *incommensurable*, a, 1b). Thus while we have knowledge about the arts, sciences and society there is no common measure other than the word ‘knowledge’ itself. The incommensurability of knowledge has been identified – explicitly and implicitly - by scholars in a wide range of disciplines including: Daniel Bell (sociology); Naom Chomsky (linguistics); Carl Jung (psychology); Stuart Kauffman (molecular biology); Thomas Kuhn (history, philosophy, sociology of science); Walter Lippman (journalism); Magorah Maruyama (psychology); Michael Polanyi (history, philosophy, sociology of science); Hans-Jorg Rheinberger (molecular biology) and, Adam Smith (economics).

2. Incommensurability is emotionally most evident in the Arts where the *Art-for-Art’s-Sake Movement*, a child of the Industrial Revolution (Henderson 1984) is continuing to generate an ever moving, shifting and changing *avant garde* (Bell 1976). It is spinning out increasingly esoteric aesthetic messages intended for ever smaller audiences, *e.g.*, atonal music and what Tom Wolfe calls “The Painted Word”, *i.e.*, when a painting is smaller than its exhibition label

(Wolfe 1975) to 'egalitarian realism' or the 'poke-in-the-eye' school of art ([Chartrand Summer 1991](#)). The incommensurability of artistic knowledge can be summed up in the aphorism: "I know what Art is when I see it and that's not Art!"

3. Noam Chomsky introduced to linguistics the analogy of language as a genetic but abstract organ. Like the physical organs of the body, the language organ develops through the life stages of the individual. Its capacity can be increased through exercise like the muscles of an athlete but genetic endowment and disposition can be taken only so far. Chomsky uses post-Schonbergian music as a limiting case:

Modern music is accessible to professionals and may be to people with a special bent but it's not accessible to the ordinary person who doesn't have a particular quirk of mind that enables him to grasp modern music let alone make him want to deal with it. (Chomsky 1983, 172)

4. Carl Gustav Jung, in analytic psychology, explicitly uses the word 'incommensurability' to define the rupture between reason and faith. While both concern the same empirical world, their incommensurability represents "a symptom of the *split consciousness* which is so characteristic of the mental disorder of our day" and of modern society as a whole ([Jung \[1956\]1970, 285](#)).

5. Stuart Kauffman, in molecular biology, using Wittgenstein's concept of 'language games' notes the:

systematic difficulty ... in attempts to reduce one language game to another for example, from a description of a legal event to a description in terms of mere human actions to a description in terms of physical events... descriptions of the doings of autonomous agents, even bacteria acting on their own behalf to get dinner - seem to involve a different language game than mere descriptions in terms of physical events. (Kauffman 2000, 126).

Kauffman uses this difficulty to illuminate a major difference between biology with its 'language games' of autonomous agents from physics and chemistry in which lifeless stuff is pushed and pulled by measurable forces. Put another way, they are incommensurable.

6. In his seminal work, *The Structure of Scientific Revolutions*, Thomas Kuhn observed that specialization and puzzle-solving within the paradigm of normal science generates knowledge that is 'incommensurable' (Kuhn 1996, 103, 112, 148, 150) even to neighbouring specialties and, by extension to other knowledge domains, disciplines and society as a whole. Semi-permeable barriers or paradigms separate specialties fostering specialization and generating dramatic growth in our knowledge and control of the physical world. The very success of the natural sciences, it has been argued, rests on the axiom: "good paradigms make good neighbours" (Fuller 2000, 7). This specialization by paradigm led Price to coin the phrase

‘invisible colleges’ to describe the forty or fifty people in the world who can understand what is being said or written in any given specialty of the natural and engineering sciences (Price 1963).

7. If the invisible college symbolizes the incommensurability of specialized knowledge, then public opinion represents “the insertion between man and his environment of a pseudo-environment” (Lippman 1922, 15). Knowledge of this pseudo-environment is incommensurable with immediate personal experience. In a complex society, one’s immediate surroundings are a very small part of a much larger environment about which one can have only indirect knowledge or experience. Knowledge of this wider world is derived not through the senses but through what Walter Lippman called *Public Opinion* in his study of propaganda and the mass media during the First World War (Lippman 1922). In his introduction entitled “The World Outside and the Pictures in Our Heads’, Lippman uses the poignant example of a few English, French and German nationals living on an isolated island in 1914 where “for six strange weeks they had acted as if they were friends, when in fact they were enemies” (Lippman 1922, 3).

8. Psychiatrist Magorah Maruyama whose work includes design of human space settlements coined the term ‘paradigmatology’ to capture the incommensurability of knowledge between different professional practices confronting the same objective reality (Maruyama 1974). Consider a social worker consulting a client family made up of an alcoholic father, a promiscuous mother and delinquent children. This is an objective reality that can be shared using a language that permits communication between the professional and the client. The social worker returns to an office where this ‘objective reality’ is discussed using another language with colleagues. In turn, the case worker reports to an administrative supervisor (in yet another language) who, in turn, reports to a ‘political master’ using yet another language. It is the same objective reality yet different paradigms come into play. And these paradigms exhibit varying degrees of incommensurability.

9. Michael Polanyi writes explicitly of incommensurability between what subsequently become known as codified and tacit knowledge in technical performance (1962a, 174). Elsewhere he implies that: (i) knowledge obtained through belief defined by articles of faith and that derived through science are incommensurate; (M.Polanyi 1952, 217) and, (ii) scientific and technological knowledge are incommensurate reflecting:

the profound distinction between science and technology [which] is but an instance of the difference between the study of nature on the one hand and the study of human activities and the products of human activities, on the other. (M.Polanyi 1960-61, 406)

10. Hans-Jorg Rheinberger (1997), a molecular biologist and philosopher of biology, has proposed that what scientists discover using “experimental systems” are not facts or truth but rather “epistemic objects” whose meaning changes and are incommensurable between experimental situations. In a rather long quote he demonstrates his point with respect to the term ‘gene’:

For a biophysicist working with a crystalline DNA fiber, a gene might be sufficiently characterized by a particular conformation of a DNA double helix. If asked, he or she might define a gene in terms of the atomic coordinates of a nucleic acid. For a biochemist working with isolated DNA in the test tube, genes might be sufficiently defined as stretches of nucleic acids exhibiting certain stereochemical features and sequence recognition patterns. The biochemist can reasonably try to give a macromolecular, DNA-based definition of the gene. For a molecular geneticist, genes might be defined as instructive elements of chromosomes that eventually give rise to defined functional or structural products: transfer RNAs, ribosomal RNAs, enzymes, and proteins serving other purposes. Molecular geneticists certainly will insist on considering issues in terms of replication, transcription, and translation and will require examination of the products of hereditary units when speaking of genes. For evolutionary molecular biologists, genes might be the products of mutating, reshuffling, duplicating, transposing, and rearranging bits of DNA within a complex chromosomal environment that has evolved through differential reproduction and selection. Therefore, they will rely on concepts such as transmission, lineage, and history. For developmental biologists, genes might be sufficiently described, on the one hand, as hierarchically ordered switches that, when turned on or off, induce differentiation, and on the other hand, as patches of instructions that are realized in synchrony through the action of these switches. Thus, developmental biologists are likely to refer to the regulatory aspect of genetic circuitry when defining a gene or a larger transcriptional unit such as an operon. We could go on and add more items to the list. (Rheinberger 1997, S248)

11. Incommensurability is also implicit in Adam Smith’s argument that public education is necessary to mitigate the damaging, or what Marx would later call, the ‘alienating’ effects of the division and specialization of labour on workers’ minds. Of the worker, Smith wrote: “his dexterity at his own particular trade seems, in this manner, to be acquired at the expense of his intellectual, social, and martial virtues” (Smith 1776). This is the shadow-side of the contemporary division and specialization of knowledge, a wraith that Adam Smith arguably foresaw.

4.6 Language

1. In the introduction to his essay “The Question Concerning Technology”, Martin Heidegger observes that “All ways of thinking, more or less perceptibly, lead through language

in a manner that is extraordinary” (Heidegger 1955, 3). Trans-disciplinary induction can arguably accommodate the biological imperative to know as well as the immeasurability and incommensurability of knowledge. It cannot, however, escape the meta-methodological dilemma presented by language. Knowledge, excepting tacit and tooled forms, finds general expression through a human language, each of which, including mathematics (Boulding 1955), is subject to inherent conceptual and other limitations. As previously observed, this is certainly the case with English, the language of this dissertation. One verb, ‘to know’, etymologically veils four distinct meanings: to know by the senses, mind, doing and experience. In this way, the English ‘knowledge’ is a linguistic or etymological monad. In German, by contrast, there are four separate and distinct verbs to express each of these meanings.

2. A word, of course, is part of a language that in turn is the foundation of the traditional ‘nation’ or ‘people’, *e.g.*, the Chinese, English, French, German or Japanese language, nation and/or people. In addition to words or vocabularies, languages differ in their grammar including their syntax, *i.e.*, the ordering of words, and, when reduced to writing, they differ in alphabet (phonetic) and/or script (ideographic), *e.g.*, Cyrillic, Kanji, Mandarin, Roman, *etc.*, and, arguably, mathematics.

3. Spoken and written language is a defining feature of our species. It is the primary but not exclusive means by which human knowledge is expressed and exchanged between individuals and across generations. Sometimes, however, as with the Logical Positivists, language is treated as synonymous with knowledge which leads to other forms of knowledge being ignored. This has been called “semantic ascent” (Baird 2004, 8). Nonetheless, “if language-in-use is this all-embracing sort of activity, stylizing most of our other activities as human beings, then man is best defined, not simply as a rational animal but as *animal symbolicum* - the language-using animal” (Aldrich 1969, 389).

4. To cite an example: Kawasaki in his analysis of science education notes that in Japanese there are no proper nouns in the Platonic sense of ‘idealized forms’ (Kawasaki 2002). Hence abstract concepts such as ‘the computer’ or ‘acceleration’ have meaning in Japanese only as specific experiential cases, not as abstract idealized forms. He suggests this may explain why the Japanese have excelled in technological innovation but lagged in the pure sciences. In contrast, the presence of abstract idealized nouns in English may explain why in my survey of seventeen sub-disciplines there was no etymology of the word ‘knowledge’ or ‘to know’. In effect, knowledge is treated in discussion of the knowledge-based economy as a universal, as a linguistic monad, not a particular.

5. In effect, language provides the web of understanding that holds culture together as an organism. Put another way, “our symbol systems, especially language, allow us to pursue the curious mix of cooperation and competition that is our species’ ‘form of life’” (Grene & Depew 2004, 336). The how and why of language acquisition by the human species, however, remains contentious.

6. No matter the how and why, the fact remains that we express most knowledge through language and each language has strengths and weakness. Thus while French is a truly precise and beautiful language, all nouns are masculine or feminine with no neuter which in a world of gender politics is a weakness. Alternatively, in English the word ‘knowledge’ is an etymological monad enfolding four distinct meanings that have their own separate nouns in German. Similarly, as noted above, there are no abstract Platonic nouns in Japanese. Even mathematics has strengths and weaknesses as noted by Kenneth Boulding in his 1955 essay “The Limitations of Mathematics: An Epistemological Critique”:

The delicacy or coarseness of a tool has an important effect on the task which can be done with it; we do not cut out cataracts with a buzz-saw or cut down trees with a scalpel. Mathematics clearly has a bias on the side of delicacy and exactness. Where the task requires delicacy, this is all to the good. If however the empirical universe which we are trying to know is not delicate, too great a reliance on mathematics may be misleading, if it is not checked by good judgment about the nature of the empirical universe itself. (Boulding 1955)

7. In summary, I have demonstrated that knowledge can be characterized as an abstract monotonic Platonic noun by reference to the undifferentiated but polymorphous biological human need to know, the immeasurability and incommensurability of knowledge and its general expression through inherently limited and biased human language including mathematics and English.

8. Before turning to knowledge as a verb some final observations on its biological nature are in order. Since publication of Darwin’s *The Origin of Species* in 1859 discussion about evolution has focused on natural selection and survival of the fittest. Nowhere in the text do the words ‘cooperation’, ‘coevolution’ or ‘coconstruction’ appear. More recent research reveals that Darwinian survival of the fittest must be complimented by an equally important test. Specifically living systems are characterized by increasing complexity resulting from progressive division and specialization of autonomous agents achieved through mutuality, *i.e.*, coevolution and Coconstruction (Kauffman 1990; 1995; 2000). Put another way, life involves not just predator and prey but also symbionts and partners.

9. With respect to human knowledge coevolution and coconstruction take on additional significance because of a second human genetic code: codified and tooled knowledge. As noted by Grene & Depew, the human neonate is, from birth, exposed to and interacts with both forms of knowledge (Grene & Depew 2004, 332). Development is patterned not just by the current generation of parents, siblings, cousins and relatives but also by the accumulated and surviving knowledge of past generations frozen into extra-somatic matrices. Whether it is the history of the Roman Empire described in a book or the urban grid laid down at the historical founding of a city, contemporary human life coevolves with codified and tooled knowledge frozen in the past. It is in this sense that, like Isaac Newton, we all stand on the shoulders of giants. As previously noted, coevolution and coconstruction will play a critical role in my subsequent distinction between the *competitiveness* and the *fitness* of nations.

5.0 KNOWLEDGE AS VERB

1. Having defined knowledge as a monotonic abstract Platonic verb, I will expand definition to include knowledge as a verb, specifically as a diaphonic verb speaking in two voices. “The tradition that there is a non-rational kind of knowing that rivals or even surpasses rational knowledge is as old as philosophy itself” (Dorter 1990, 37). These two realms – the rational and non-rational – have been at odds since the beginning of Western thought. And while the rational is embodied in our contemporary concept of Science, the non-rational has remained a wraith taking many forms, assuming many names and evading systemic identification. To Plato it was Art; to the Church Fathers it was Revelation; to the Scholastics it was analogy; to Adam Smith, it was moral sentiments; to Kant, it was ‘productive imagination’; to Michael Polanyi, it was subsidiary or tacit knowledge; to Thomas Kuhn, it was aesthetics, gestalt switching or intuition with “lightning flash”, “illumination” and “scales falling from the eyes” (Kuhn 1996, 111, 123, 155, respectively). To Erich Jantsch, it was Design (1975).

2. Having scanned, collected, sorted, compiled and considered argument and evidence of ‘knowledge about knowledge’ from the event horizons of seventeen sub-disciplines, this common theme was induced: *Science by Design*. In brief, there are two distinct yet intimately interrelated, interpenetrating and overlapping realms of human knowing:

- Science (or more broadly, reductive reasoning) that finds highest abstract expression in mathematics and highest concrete expression in instrumental science; and,
- Design which is a complex of human capabilities that finds highest abstract expression in the aesthetic/intellectual/spiritual experience and highest concrete expression in works of aesthetic and “technological intelligence” (Aldrich 1969, 381). In brief, it invokes pattern construction and recognition.

3. In all human activities - art, science, politics, religion, sport – both realms, both ruling powers, are at play. Differences are in balance, concentration, degree, focus or priority. I will first examine the idea of Science then Design and finally propose a reconciliation that may satisfy Kauffman’s hope “to glimpse a *constructivist* companion to the reductionist thesis” (2000, 268). In effect, I will argue that modern Science emerged from, is the progeny of, or is by way of a more generic and ancient realm of knowing called Design, hence, *Science by Design*. I will, in effect, argue that if the elemental biological human need to know is the

material cause of knowledge then Science by Design is its efficient cause, the agency of knowledge.

5.1 Science

1. The unprecedented evolutionary ascent of our species to global dominion, achieved in some twenty-five generations, arguably resulted from the institutionalization of a new way of knowing - the experimental method, or, as it was originally known, ‘experimental philosophy’. Developed by craftsmen of the late or High Middle Ages of the western European civilization (Zilsel 1945), it was first fully articulated by a late Renaissance genius, Sir Francis Bacon in his *Of the Proficiency and Advancement of Learning Divine and Humane*, published in 1605.

2. According to Bacon, human dominion was to be achieved by reducing Nature’s complexity through *instrumentally* controlled experimental conditions forcing her to reveal her secrets. She did. The question was first put using instruments developed in the craft workshops of the European Age of Discovery. It was here that Bacon saw the prototype of his ‘House of Solomon’, the house of wisdom and of knowledge. He called on scholars, practitioners of the Liberal Arts, to come down from their ivory towers and test Nature in the workshops of the Mechanical Arts where, in his time, the necessary instruments were available. He also called for a History of the Trades to provide scholars with an understanding of the findings about Nature made by the rapidly advancing Mechanical Arts, *e.g.*, ballistics, metallurgy, navigation, ship construction, *etc.* In this regard, Galileo’s research was in part funded by what today would be considered military contracts (Hill 1988).

3. It is therefore ironic that the concept of modern experimental instrumental science subsequently became hostage, first to class prejudice, then to propositional logic and finally, today, to sociological deconstruction. To explain this Babylonian captivity I draw mainly on three scholars, two of whom are Marketers (Michael Polanyi and Thomas Kuhn) while the third is a Marxist (Edgar Zilsel). Another connexion between them, not examined here is Copernicus, about whom each wrote (Zilsel 1940b; Kuhn 1957; Polanyi 1967).

4. Since the beginning of Western civilization, logic has been accepted as the preferred path to knowledge (Dorter 1990, 37). It distances us from our passions; it frees us from the distracting world of sensation and emotion. In the hands of the Romans the Greek *logos* became ‘reason’ derived from the Latin ‘ratio’ as in to calculate (OED, *reason*, n 1). And from the Romans we derive Science from the Latin *scire* “to know” which, in turn, derives from *scindere* “to split” (MWO). Science today is accepted as the epitome of reason deriving knowledge by

splitting or reducing a question into smaller and smaller parts or elements until a fundamental unit or force is revealed, *e.g.*, Bentham's utile or Newton's gravity. Until innovation of the experimental method, however, such splitting and reducing was restricted to words.

5. Reductionism extends to epistemology, *i.e.*, the theory of knowledge. Knowledge itself has been split into domains, disciplines, faculties and forms with an inevitable increase in incommensurability. Reductionism has, however, a significant advantage. It strips away secondary phenomena distinguishing cause from effect revealing in the natural sciences underlying 'laws of nature' (Taylor 1929, 1930; Zilsel 1942). Its success rests on the testing of cause and effect, or 'when-then' causality with Time's Arrow moving out from the Past into the Present and then into the Future by way of prediction.

6. The critical epistemological difference between ancient and modern Science, leaving aside for the moment mathematics, is the scientific instrument forcing or reducing Nature to reveal her secrets. Epistemologically, Idhe calls this 'instrumental realism' (Idhe 1991). It is the design, development and operation of instruments of ever increasing sensitivity that has allowed humanity to pierce the veil of Nature, of appearances, and establish human dominion. Such instruments are not verbal constructs; they are tangible works of technological intelligence that measure and manipulate matter and energy.

7. Less than sixty years after Bacon formally articulated the new experimental philosophy, it attained political and religious legitimacy with a royal charter granted by Charles II to *The Royal Society of London for the Improvement of Natural Knowledge* incorporated in 1662 (Jacob & Jacob 1980). After its founding the Royal Society made several attempts to realize Bacon's dream of erecting its own custom-built 'House of Experiment' (Shapin 1988). This was intended not only to provide facilities for the conduct of experiments but also for 'artificial revelation' for the general public (Price 1984, 9). Transparency and openness to public scrutiny, or witness, was also a Baconian ideal. It was to be though openness that public trust would be built and superstition dispelled. All attempts, however, failed. The Royal Society became a 'talk shop' for peer review of research conducted elsewhere and then published in its *Philosophical Transactions*. Similarly, the history of the trades was never completed and quietly faded from view.

8. According to what I call 'the Houghton Hypothesis', this turning away from the Baconian vision was the result of certain founding members of the Royal Society known as the *virtuosi*, most especially John Eveyln.

And what is true of Evelyn is true in general of the *virtuosi*, for we know that by 1667 natural philosophy had "begun to keep the best Company, and refine

its Fashion and Appearance, and to become the Employment of the *Rich*, and the *Great*, instead of being [as it still largely was in Bacon's time] the Subject of their *Scorn*." (Houghton Jan. 1941, 72).

9. The virtuosi were rich, educated curiosity seekers who sought neither knowledge-for-knowledge-sake nor utilitarian purpose. Rather they sought *divertissement*, diversion or entertainment with a consuming passion for the marvelous (Houghton Apr. 1942, 193), *i.e.*, they wanted new and better toys. Scientific experiments were, to them, like antiquities, art and exotic seashells, *i.e.*, curiosities.

10. These Cavaliers of the mind viewed the crafts as unworthy of gentlemen. They looked down upon the utilitarianism of their Roundhead compatriots who had won the civil war but lost the final battle with restoration of the monarchy and reestablishment of the gentle classes. Thus, Evelyn "... abandoned the history of trades, which Bacon [urged]..., because of 'the many subjections, which I cannot support, of conversing with mechanical capricious persons'" (Houghton Apr. 1942, 199).

11. The Baconian ideal of the marriage of head and hand was, however, briefly resurrected in France about a hundred years later just before the Revolution, by Diderot, in his famous *Encyclopaedia* article entitled 'Art':

There, the cutler's son made a plea for the mutual aid that the *savant* and craftsworker should offer one another. Theoretical training was counterproductive unless combined with a practical knowledge of basic physical properties. In the same breath, however, Diderot showed his appreciation of the organizing power of theoretical science by calling for a 'Logician' to invent a 'grammar of the arts'. He deplored the secrecy and venality of the various guilds, which he felt stifled technical innovation... (Alder 1998, 508)

12. Arguably, 'gentrification' of Baconian science by the *virtuosi* delayed the Industrial Revolution in England by a century. It was not in fact until 1809 that the first research university was founded, not in London, but in Berlin transforming the mandate of the university - traditional and conservative heartland of Western knowledge - from interpretation of old to the generation of new knowledge. In England, Science continued to be a gentleman's pastime generally practiced outside the university for the next two or three generations. In fact,

The men responsible for technological innovations . . . during the beginning of the Industrial Revolution were nonconformists who had been excluded from the universities and learned their science indirectly while pursuing their trade. In other words, the coupling between science and technology was very loose and did not rely on the established system of higher education. (Senate Special Committee 1970: 21)

13. It was also in the German-speaking world, but this time in Vienna, that articulation of the first modern philosophy of science was made in the 1920s by the so-called Vienna Circle. The Circle was made up of Otto Neurath, Moritz Schlick, Rudolf Carnap, Richard von Mises, Gustav Bergmann, Herbert Feigl, Philipp Frank, Kurt Gödel, Friedrich Waismann and, initially, Edgar Zilsel. The fruit of their labours was Logical Positivism, later renamed (arguably due to Zilsel's criticism) as Logical Empiricism (henceforth 'LPE').

14. LPE begins with the form of scientific theories, not with scientific praxis. It assumes that the logical structure of any theory can be articulated independent of its content or instrumentation, *e.g.*, physics, biology and chemistry. The Circle, and its successors including Karl Popper and Bertrand Russell's 'logical atomism', also formulated a verifiability principle or criterion of meaning. For LPE, any statement that cannot be logically proved true by virtue of the meaning of the words contained in its proposition (extended to include mathematical symbols and operators) was meaningless unless it could be empirically tested against experience and observation. In essence, a statement is valid only if it can be tested. This criterion penetrated deeply into the social sciences especially economics, *e.g.*, Milton Friedman's *Essays in Positive Economics* (1953). Accordingly, ethics, metaphysics, religion, and aesthetics were meaningless, *i.e.*, were not knowledge. This firmly established what Michael Polanyi called 'the ideal of scientific detachment' (Polanyi 1957, 483). Based upon these premises, LPE concluded by espousing a doctrine of unified science, *i.e.*, there is no fundamental difference between physics and biology or between the natural and social sciences.

15. In effect, LPE turned Science back from experimental philosophy, or what Rheinberger calls 'epistemic systems' (Rheinberger 1997), to linguistic and mathematical logic in the process arguably becoming a form of post-Scholasticism. Zilsel, concerned with "analysis of the relationship between the rational laws of probability and empirical causal laws of nature" (Raven & Krohn 2000, xxxix), could not accept LPE as 'empirical', *i.e.*, found in the real world of history, especially that of scientific discovery and practice. Zilsel despised all attempts by "schoolmasters... who would separate... philosophy from the empirical disciplines" (Raven & Krohn 2000, lv). In effect, LPE invokes what Baird (2004, 8) calls 'semantic ascent' up and away from the instrumental experimental realism of modern science. One is left with words, not empirical science. Like the English *virtuosi*, LPE practioners did not like to work with their hands, nor did they like those who did. Zilsel, on the other hand, was a Marxist.

16. With respect to LPE's treatment of mathematics, Michael Polanyi observed:

This radical positivism taught that science consisted merely in establishing functional relations between the data observed by our senses and that any

claim that went beyond this was undemonstrable. A reality underlying mathematical relations between observed facts was a metaphysical conception, without tangible content. (Polanyi 1967, 178)

17. By the end of the 1940s LPE had declined in intellectual force as its aims proved unattainable, *e.g.*, the unity of all sciences.

Its theories were softened down then by a series of qualifications, which amounted to abandoning any attempt at establishing a formal criterion of the meaning and validity of a scientific statement. The rise of analytic philosophy confirmed this abdication by abandoning the critique of science. Thus we are left today without any accepted theory of the nature and justification of natural science. (Polanyi 1967, 178)

18. Polanyi's 1967 reference to 'analytic philosophy' is of specific relevance to the Anglosphere where it continued the path of semantic ascent (Ryle 1949; 1968). He did not, however, take account of what was happening in Western Europe where another direction was taken towards the sociological deconstruction of science. French philosophers such as Derrida (1930- 2004) and Foucault (1926–84) argued that Science, like all forms of human expression, is based on the sociological (or class) structure of society. Science is about power and understanding Science requires 'deconstruction' of texts and situations to determine who has the power, *e.g.*, to have one scientific theory accepted and another rejected. That political power could warp Science, however, had already been demonstrated to Polanyi by the Lysenko affair in the Soviet Union (Polanyi 1950, 36)

19. Polanyi also did not account for the peculiar impact in the Anglosphere of Thomas Kuhn's 1962 *The Structure of Scientific Revolutions* (Kuhn 1996). This spawned what Idhe calls 'the new philosophy of science' (Idhe 1991). Kuhn's first edition models scientific puzzle-solving within paradigmatic limits stressing the cognitive break that occurs with successive scientific revolutions. While anomalies may accumulate raising doubts about the validity of a paradigm, no revolution is possible without "scales falling from the eyes", "lightning flash" and "illumination" (Kuhn 1996, 123). Cognitive psychology, rather than the sociology of a specialized community of interest sharing the same instruments, language, practice, talent and theory, was his initial focus. Specifically, he was concerned with scientific revolutions, not 'normal science'.

20. By the second edition of *Structure* in 1970, and especially in his 1990 article "[The Road since Structure](#)", Kuhn responded to critics of his 'metaphysics' by shifting emphasis to the sociological paradigm of 'normal science'.

In reaction, sociologists, and even some philosophers of science, have practiced a sociological deconstruction of science, which has left that family

of disciplines with no claim whatsoever to epistemic justification. For the first school [*LPE*], science, with its sacrosanct method, stands serenely outside society, or else deigns to direct it by applying its superior procedure. For the second, science is reduced to politics: In effect, there is only society, no science.” (Greene & Depew 2004, 348)

21. Arguably today there is therefore no ‘Standard Model’ of the philosophy of science. Without a clear and articulate philosophy it is difficult for the general public to understand what Science is, and is not. Bacon and Conant wanted the general public to learn about Science in order to gain trust and respect for its practioners and leave them alone. This campaign has continued in the media and in the schools since Conant’s time but enrollment in science, engineering and mathematics, at least in the Anglosphere, continues to fall and the public is arguably becoming increasingly distrustful of big ‘S’ science.

22. The issue of GM food is a case in point. Well researched and well meaning ‘risk assessments’ are presented to a public that finds calculatory rationalism distasteful and probability unintelligible, *e.g.*, everyone knows the odds of winning the lottery yet people keep on buying tickets. It would appear that the chances of winning are over-rated in lotteries while those of losing in the GM ‘cancer’ sweepstakes are similarly over-rated. Attempts have been made to place such questions in the epistemological context of known/unknown contingencies, *e.g.*, Khatchatourian’s placing of GM food safety within the paradigm of Kuhn’s ‘normal science’ (Khatchatourians 2002). Something, however, is missing in the public mind – a coherent picture of what Science is about. Arguably, no such picture exists, even in Science itself. There is, however, hope. For the moment, however, I must turn to Design, expressed in the philosophies of biology, science and technology, as well as in aesthetics, psychology and economics.

5.2 Design

1. The idea of ‘Design’ is eternally linked to a form of causality utterly rejected by physics and the positivistic philosophy of science – teleology: “the doctrine or study of ends or final causes” (OED, *teleology*). Using economic examples, Aristotle identified four causes of things to be the way they are:

- material cause: that out of which a thing is made, *e.g.*, economic inputs;
- formal cause: the form or shape of the final thing, *e.g.*, economic outputs designed to satisfy consumer needs;
- efficient cause: the initiating agent, *e.g.*, the entrepreneur or firm; and,

- final cause: end purpose or *teleos*, e.g., profit.

2. Physics, as well as a positivist philosophy of science, gets along quite well using only material and efficient causes (cause-and-effect) while treating formal causes as questionable and denying final causes entirely. Put another way: “The physical world that Newton envisaged was a world that could be described in terms of material and efficient causes, in terms of particles of matter that exist in space and time and are moved by force” (McLeod 1957, 478). This can be called ‘billiard ball’ science involving inanimate matter and energy that has no will or volition of its own. This is an ideological perspective that in fact was required for the political and religious legitimization of the new experimental philosophy embodied in the royal charter to *The Royal Society* in 1660 (Jacob 1978; Jacob & Jacob 1980).

3. About this charter it is important to recall three things. First, before its grant, any tampering with Nature could be construed as witchcraft and alchemy with secular and religious consequences for their practitioners. Outside of England, many experimental philosophers, including Galileo, experienced these consequences to their sorrow. Second, the English king, unlike European monarchs, was also head of the Church, the Church of England. Thus the charter was effectively an English bill of rights for experimental philosophy with respect to both politics and religion. This was unlike anywhere else in Europe. Third, it was granted nearly thirty years before the English Bill of Rights of 1689 which established a free press and democracy in England. Whether the first contributed to the second remains, for me at least, an open question.

4. In *Some Considerations touching the Usefulness of experimental natural philosophy*, written during the height of Cromwell’s Commonwealth in the 1650s, Robert Boyle provided the metaphysical rationale by placing the laws of the physical world, i.e., physics and mechanics, in stasis above and beyond human or divine intervention. This is known as the ‘Latitudinalist compromise’ (Jacob 1978). This argument was publicly expressed with the 1686 publication of Boyle’s *A Free Enquiry into the Vulgarly Received Notion of Nature*. The act of Creation had, he argued, once and forever, established the Laws of Nature. Having set the machine in motion God withdrew and Nature became the legitimate subject of experimental philosophy (Johnson 1940, 417). Ironically, Isaac Newton did not accept the new philosophy and continued to believe in miracles and divine intervention in the material world (Harrison 1995).

5. There were, however, two theological and one scientific exceptions. Theologically, the human soul and angels continued to be subject to the Divine. This limitation is reflected in Descartes’ separation of mind and body (or the ghost in the machine). This inhibition is also

apparent in the first study of humanity as a natural entity by Buffon, the father of anthropology, in 1749. He sought to be “protected from theological and philosophical objections because he carefully sequestered man’s ‘moral’ characteristics - the ‘metaphysical’ attributes of reason, free will, and so forth - from his natural history of the species” (Greene & Depew 2004, 323). The scientific exception was thus biology which had to wait for Kant, forty years later, to be at least partially liberated from religious restriction.

6. While physics functions very well with ‘when-then’ causality, many other disciplines depend on teleology or purpose to explain the object of their investigations. To understand the nature of Design I begin with etymology and then, in alphabetic order, consider its role in aesthetics, biology, economics, psychology and technology. I hope, like Kauffman’s patchwork procedure, to optimize overall understanding by considering Design in each of these disciplines of thought. Nonetheless, in doing so I know, like McLeod fifty years before me, that:

I am venturing down a pathway that for some centuries has appeared forbidding even to the angels, and that in taking a hesitant step in this direction I am identifying myself with a nonangelic group... I submit, however, that we should from time to time look again at the phenomena that invite a teleological explanation and make sure that we have done full justice to them. (McLeod 1957, 477)

5.2.1 Etymology

1. With the discovery (or re-discovery) of perspective in the visual arts in the Renaissance, a new word entered the English language – design. The word derives from the Latin *designare* “to mark out, trace out, denote by some indication, contrive, devise, appoint to an office” (OED, *designate*, v). In Renaissance Italy ‘design’ assumed its contemporary aesthetic sense of geometric composition (Aldrich 1969) as distinct from its social sense of planning with a purpose. In French, these two are expressed by separate words: “*dessein* meaning ‘purpose, plan’; and, *dessin* meaning ‘design in art’” (OED, *design*, n, etymology). In English, however, both senses are combined in the single word ‘design’. What they share is *intent*, specifically the intent to make as opposed to understand the world at the disinterested distance afforded by Science. Design involves making patterns out of matter and/or mind, *i.e.*, pattern construction, as well as recognition of purpose even in natural phenomenon like ships of clouds sailing across the living skies (Aldrich 1969, 381). The word ‘design’ itself entered the English language in 1588 followed fifteen years later in 1603 by ‘causality’ (OED, *causality*, 1), a word that arguably lies at the heart of the Scientific Revolution and is the conceptual foundation of the experimental method.

5.2.2 Aesthetics

1. Design embraces the Renaissance sense of human progress residing in human hands. The Design revolution changed not just the concept of Western knowledge but also of the ‘knower’. The artist/engineer/humanist/scientist of the Renaissance inaugurated the Western ‘cult of the genius’ that survives and thrives to this day (Smith 1996; Woodmansee 1984; Zilsel 1918). In fact, Western intellectual property rights (IPRs) such as copyrights, patents, registered industrial designs, trademarks, *etc.*, are legally based on the individual creative genius. The god-like power of human creation, *ex nihilo*, *i.e.*, out of nothing (Nahm 1947), were thus first assigned to the Renaissance masters of perspective (Nahm 1950).

2. Aesthetics as a separate branch of philosophy (generally but not exclusively associated with the *Beaux Arts* or Fine Arts) appeared in the mid-18th century with the work of German philosopher Alexander Gottlieb Baumgarten (1714–62). It is important to note that “the original meaning of the term aesthetics as coined by Baumgarten... is the theory of sensuous knowledge, as a counterpart to logic as a theory of intellectual knowledge” (Kristeller 1952, 34). In effect, Baumgarten philosophically separated Art from subordination to politics and religion roughly a hundred years after the Scientific Revolution liberated experimental philosophy from the same masters. Formal aesthetics, like Science, however, distances itself from some human senses. In effect, sight and sound (the distant senses) are admitted while the contact senses of touch, taste and smell are excluded as disruptive to aesthetic contemplation. This distinguishes the sensuous (distancing) from the sensual (immediacy) (Berleant Winter 1964).

3. Where logic leads by reduction to Truth, aesthetics leads by Design to Beauty. The relationship between the two was expressed best by the poet, John Keats:

“Beauty is truth, truth beauty,” That is all
Ye know on earth, and all ye need to know.
Ode to a Grecian Urn, 1820.

4. In Pythagorean terms, Beauty is “...a certain unity of diverse elements, [and] ... harmony can be understood as the relation of these parts to the whole, and rhythm as their relation to one another” (Dorter 1973, 74-75). Thus:

when we say that some work of art “works,” we are not referring to its factual accuracy but to the crystallization of its facets into a cogent harmonic and rhythmic unity. This sense of beauty is the essential one in art, for it is certainly possible to regard an art work as beautiful even if it is representationally “inaccurate.” (Dorter 1973, 75-76)

5. The reference to ‘works’ as a verb catches the sense of knowledge resulting from successful making. This is also true, as will be demonstrated, of works of technological

intelligence (Aldrich 1969, 381). Another aesthetic term that successfully transcended disciplinary barriers, including those of the natural & engineering sciences and mathematics, is 'elegant'. It derives from the Latin, meaning 'choosing carefully or skilfully' (OED, *elegant*, a, Etymology). One of its English meanings, however, is: "Of scientific processes, contrivances, etc.: 'Neat', pleasing by ingenious simplicity and effectiveness" (OED, *elegant*, a, 5a).

5.2.3 Biology

1. Among his many contributions Immanuel Kant (1724–1804) established, as a law of nature, that the formal notion of the if-then relationship corresponds to the concept of cause and effect and that there is a single direction of causality, *i.e.*, Time's Arrow only moves from cause to effect, from past to present to future (Greene & Depew 2004, 93-4). This law, however, was limited by Kant to matter defined as lifeless stuff (objects) pushed or pulled by measurable forces through space/time, *i.e.*, mechanics. This limitation was required because it was apparent to Kant that material and efficient causes (cause and effect) were insufficient to explain living things, *i.e.*, biology. Through his questioning he at least partially liberated the study of biology from religious ideology just as Robert Boyle had liberated physics a century before.

2. Kant addressed the question of biology in his *Critique of Judgement* (1790) which is divided into two parts. The first is the "Critique of Aesthetic Judgment"; the second, the "Critique of Teleological Judgment". The ordering is important. While works of technological intelligence, or artifacts, have purpose, works of aesthetic intelligence have purposiveness or meaningfulness but no purpose, *i.e.*, no utilitarian function.

In aesthetic judgments, and especially in judgments of the beautiful, purposiveness is ascribed without reference to purposes, and indeed in their complete absence. This prepares the way for Kant's ascription of purposiveness to living things, where purposes and purposiveness do not appear quite as separable. (Greene & Depew 2004, 101)

3. There were three aspects of living things that demonstrated to Kant that teleological or final causes were at play. I will call these: ecology, metabolism and ontogeny.

4. First, Kant could see that the web of mutually supportive relationships between various species of plants and animals constituting an ecology or ecological community was so complex that linear 'when-then' causality was simply insufficient to explain its existence. Second, in the metabolism of living things "each part is reciprocally means and end to every other. This involves a mutual dependence and simultaneity that is difficult to reconcile with ordinary causality" (Greene & Depew 2004, 94). Third, in ontogeny, or development of the individual, the

future mature end-state seems to guide successive stages of development. This appears a clear case of formal and final cause at work.

5. Having found teleological processes in living things, Kant was concerned to distinguish between Design and designer. To do so he contrasted machines (works of technological intelligence) from living things. Quite simply, parts of a machine are put together by people and parts do not bring other parts into existence, *i.e.*, a machine is not a self-organizing entity. By contrast:

the parts of an organism are so mutually dependent and so tightly connected with the whole that it is difficult to say what, if anything, should come first and what should come later, as we must do when we design, build, and analyze (“reverse engineer”) artefacts. In this respect, Kant says that organisms are - or at least must be grasped by us as - self-formative, bootstrapping operations, in which each part appears to be the joint product of all the other parts. This is what Kant means when he says that an organism is “a product of nature in which everything is both an end and also a means” and in which the parts are “reciprocally cause and effect of [one another’s] form.” (Greene & Depew 2004, 98-99)

6. For Kant artifacts, machines and all other works of technological intelligence are finally caused by human purpose. Living things, however, do not require human or divine purpose but rather reflect a ‘natural purpose’. Kant called this form of causality *purposiveness*. He was so convinced of the inherent complexity of living things that he claimed:

it is absurd for human beings even to attempt it, or to hope that perhaps some day another Newton might arise who would explain to us, in terms of natural laws [cause and effect] unordered by any intention, how even a mere blade of grass is produced. (quoted in Greene & Depew, 2004, 94).

It should be noted, however, that Kant prioritized these two forms of causality - mechanistic and purposive – always allowing mechanistic explanations, when available, to trump purposive causation. Thus he restricted the term “explanation” exclusively to mechanistic causality (Greene & Depew 2004, 107).

7. Kant wrote, however, just as the Cambrian explosion of knowledge was gaining momentum. Since his time, the experimental method has revealed much more about the nature of life. For example, Kauffman can now argue that Kant’s natural purpose is inherent in the chemical nature of matter itself. Given a sufficiently rich chemical broth, coevolution and coconstruction of ever more complex organic molecules will culminate in life (Kauffman 2000). In evolutionary terms, natural selection is thus complimented by the tendency of chemically active matter to assume increasingly complex form. We also now have technology to directly affect (or infect) living things with human purpose, *i.e.*, biotechnology. In effect, the new

science of genomics combines human and natural purpose. One implication is that “it has become possible to think that biology can, for the first time, join physics and chemistry as a ‘technoscience’” (Greene & Depew 2004, 345).

8. Why matter is inclined to increasing complexity remains to be explained. Nonetheless, that matter forms increasingly complex patterns culminating in life cannot be denied, nor that living things have teleological purpose which, at a minimum, is survival and reproduction.

5.2.4 Economics

1. As previously demonstrated economics engages all four Aristotelian causes. In summary, the entrepreneur (efficient cause) is driven by profit (final cause) to manipulate inputs of matter and energy (material cause) into final outputs (formal cause) to satisfy human wants, needs and desire. Outside of the Standard Model, a number of economists have treated Design, expressing it, however, in widely varying terms.

2. Nathan Rosenberg, for example, has made explicit and extensive use of Design in his studies of innovation and ‘the black box’ (1974, 1976, 1994). He also complains about “academic snobbery” regarding “matters involving ‘hardware,’ including techniques of instrumentation, [that] are often dismissed as constituting an inferior form of knowledge” (Rosenberg 1994, 156). Similarly, Dasgupta and David identify the concept of “technological knowledge” which they argue should not “be assigned a subordinate epistemological status” to scientific knowledge, *i.e.*, that derived by linear cause and effect (Dasgupta & David 1994, 494).

3. Ekkehart Schlicht, for his part, identifies pattern recognition as the means by which human institutions, customs and traditions are formed and maintained. These emerge, he argues, according to “rule preference” which “is of an essentially aesthetic nature” (Schlicht 2000, 40). Schlicht also notes that “customs, habits, and routines provide the bedrock for many economic and social formations yet our understanding of the processes that underlie the growth and decay of customs is very limited. The theory of social evolution has hardly commenced to evolve” (Schlicht 2000, 33). This runs, of course, completely against the Benthamite underpinnings of the Standard Model in which custom and tradition are excluded from consideration.

4. Brian Loasby (2003), in turn, places pattern recognition on ‘the seat of consciousness’ (OED, *wit*, n, I.1) displacing calculatory rationalism. The energy efficiency of pattern recognition compared to continuous calculation has, in evolutionary terms, made pattern recognition the dominant realm of human knowing. In the simplest terms, pattern recognition is dependent on the quality not the quantity of data. It is relational not reductive. According to

Loasby, such patterns form ‘connections’ altering the structure of the brain itself. His concept, which derives from Adam Smith and Fredrick von Hayek (1952), I call ‘connective knowledge’. Such patterns also characterize human behaviour which, when followed by many individuals, becomes what Loasby calls ‘routines’ or what I call ‘institutions’, *i.e.*, routinized patterns of collective human behaviour. An example is the price system which emerged, and functions without conscious human planning yet is a product of human intelligence (Hayek 1989) created perhaps through circular causality (Freeman 1999) or the related economic concept of cumulative causality (Myrdal 1939).

5. Two forms of knowledge also form Adam Smith’s ‘system of social science. As is known, knowledge is gained in the *Wealth of Nations* (Smith 1776) through progressive and expanding division and specialization of labour, *i.e.*, by reduction. In *The Theory of Moral Sentiments* (Smith 1759), however, knowledge is obtained through an innate moral sense or sympathy serving as the basis of market trust, *i.e.*, by pattern recognition or Design.

5.2.5 Psychology

1. From psychology I draw upon two sub-disciplines to demonstrate the role and place of Design – analytic and gestalt psychology.

2. The compositional unity identified by aesthetics in the 18th century arguably led to the formation of a new school of psychology in the 20th. Gestalt psychology was founded by Max Wertheimer, Kurt Koffka and Wolfgang Köhler in Germany in the early 20th century (Köhler 1959). The word *gestalt* derives from the German meaning “a ‘shape’, ‘configuration’, or ‘structure’ which as an object of perception forms a specific whole or unity incapable of expression simply in terms of its parts (*e.g.* a melody in distinction from the notes that make it up)” (OED, *gestalt*). If one looks at a tree one sees a whole, an entity, not a composite of leaves, branches, trunk and root. If one shifts attention to a part, the whole is lost from view. In effect, it is perception (knowledge) without reflection or projection. By reflection I mean interpretation or ‘thinking about’ the meaning of the image. By projection I mean ‘reading into’ the image an *ex poste* interpreted meaning. Or, as Jung says: “image and meaning are identical; and as the first takes shape, so the latter becomes clear. Actually, the pattern needs no interpretation: it portrays its own meaning” (quoted in Hillman 1980, 37). Here is knowledge without reason. Any attempt to analyze it, *i.e.*, to reduce a work to its component elements sacrifices knowledge of the whole. Analysis is reductionism, not composition.

3. In the last half of the 20th century another incarnation of this non-rational way of knowing emerged, this time out of cognitive psychology through the study of neural networks and computer science with the study of artificial intelligence. It is formally called ‘pattern recognition’. Such research has led at least one observer to conclude that Science “is just another aspect of a fundamental human capability, that of pattern recognition and processing” (Sparkes 1972).

4. In analytic psychology there are many examples of pattern recognition of complexes and archetypal patterns of thought shared by all humanity in its collective unconscious (Jung [1954] 1970, 10). Some of these patterns have been formalized into testable typologies such as *The Myers-Briggs Type Indicator* ®. Used extensively in North American business and education it attempts to identify and measure the faculties of knowing possessed by an individual. The mix of ‘types’ reveals how each individual learns best, *i.e.*, accumulates knowledge, and best makes decisions. For my immediate purposes, however, I wish to highlight a patterning in Time identified by analytic psychology - synchronicity or the acausal connecting principle (Jung [1952] 1973).

5. Alternatively known as ‘meaningful coincidence’, synchronicity refers to the coincidental, yet meaningful, occurrence of events co-terminus in Time but with no causal connexion in space, *i.e.*, no mechanical cause and effect. Synchronicity has been used to address questions such as: Why do things seem to happen in threes? Is there a connexion between mind and matter? (Peat 1987) and, Is there a pattern to human destiny? (Progoff 1973). Synchronicity was also used by Jung to distinguish the Chinese mindscape in his introduction to the *I Ching or Book of Changes* (Wilhelm 1950). This highlights a critical dimension of the global knowledge-based economy: that which constitutes knowledge varies, sometimes significantly, between cultures.

6. There is, however, another, rationale for synchronicity rooted in Martin Heidegger’s *Being and Time* (Heidegger [1927] 1996). As previously noted, Heidegger found that human thought (and therefore knowledge) operates only in Time, not in Space. Given the uni-dimensionality of thought it should not be surprising that the human mind is prone to find patterns or connexions between events in a given moment in Time – whether or not they are causally linked.

5.2.6 Technology

1. While no generally accepted term *contra* Science has emerged, to the ancient Greeks the closest was *techne* roughly meaning the useful or mechanical arts. The distinction was based, however, upon class: nobles practiced the Liberal (or free) Arts; slaves practiced the Mechanical Arts. It is from *techne* that, in 1859 the word ‘technology’, as we understand it, entered the English language (OED, *technology*, 1b). Ominously, however, Aldrich argues that the classicist attitude of studied indifference towards technology continues today but with the mechanical device cast in the role of slave (Aldrich 1969, 383). This may partially explain why enrollment in science, engineering and mathematics has declined in the Anglosphere, *i.e.*, cultural contempt. This was certainly M.J. Wiener’s conclusion in his 1981 *English Culture and the Decline of the Industrial Spirit, 1850 – 1980* treating the economic condition known in the 1970s as the ‘British disease’ before Margaret Thatcher came to power.

2. In the history and philosophy of technology Edwin Layton stresses Design as a form of knowledge distinct from Science and highlights the central role it plays in engineering (Layton 1974). Similarly Derek De Solla Price highlights the distinct cognitive impact of scientific instruments compared to reason and theory. This is captured in his description of the impact of Galileo’s telescope as “artificial revelation” (Price 1984, 9).

3. Works of technological intelligence are in fact recognized or ‘known’ by their purpose or intent. In the philosophy of science, Michael Polanyi cites the hammer as an example (M.Polanyi 1962a, 175). In the philosophy of technology this sense is captured by ‘instrumental realism’ (Idhe 1991) and ‘instrumental epistemology’ (Baird 2004) that, in turn, derive from Heidegger’s existential phenomenological hammer (Idhe 1991). (The connexion between Polanyi’s and Heidegger’s hammer will be discussed below.) Baird, for his part, explicitly identifies the “design paradigm as the most promising recent development in the epistemology of technology” (Baird 2004, 149).

4. Arguably, however, technology represents the ultimate in human Design. As Heidegger (Heidegger 1957) suggests technology enframes and enables human life. In effect, it constructs a distinct human ecology growing ever more distant from Nature as the knowledge explosion continues to expand. An extreme example is space travel during which humans cannot live in the natural environment, nor on any off-world destination of which we know. Even on Earth, as previously noted the average Canadian now spends 94% of one’s time cocooned within a human built environment. Consider coming home from the office in a car, unlocking the door to the house, turning on the lights, making supper using appliances, watching television, checking

one's email then driving to the local mall to shop. All is technology. Technology enframes and enables us, defines and patterns activity in the human ecology.

5.3 Reconciliation

1. As demonstrated above, whether it is aesthetics, biology, economics, engineering, physics, psychology or technology, behind the bright focal light of reductive Science there lurks a subsidiary, non-rational, shadowy, background way of knowing called Design. Design relies on final and formal causes. Positivistic Science relies on material and efficient causes, *i.e.*, cause and effect. How can this duality of Science & Design be reconciled? How can material, formal, efficient and final causes be re-united some 2,400 years after Aristotle and 400 years after the Scientific Revolution? In terms of the Ancients, how can we achieve *enantiodromia* – a resolution of apparent opposites?

5.3.1 Accept the Paradox

1. One solution is to simply accept their opposition and use each appropriately. This is the solution in physics with respect to the particle/wave paradox of light: sometimes it is a particle, sometimes a wave. Arguably, this is the state of affairs today - epistemological pragmatism. Alternatively, one may be a special case of, or descendent from the other, *e.g.*, Science as a special case of Design, or *vice versa*.

5.3.2 Design as a Special Case of Science

1. If Design is a special case of Science then resolution lies in more detailed reduction of the material world of DNA, neurons, lobes and brain stems. If one were to apply only material and efficient causality, *i.e.*, the 'when-then' causality of mechanics, one arrives, however, at a most uncomfortable conclusion:

Admitting that no process known to be governed by the present laws of physics and chemistry is also known to be accompanied by consciousness, we might yet suppose that a future enlargement of physics and chemistry might account for the sentience of certain material structures. It would seem unwarranted to retain for such structures the conception of automatic functioning, which is derived from our *present* physics and chemistry. Action and reaction usually arise together in nature. Hence, it would seem reasonable to expect that the new physics and chemistry, which would account for the production of consciousness by material processes, would also allow for the *reverse* action, that is, of conscious processes acting on their material substrate. (Polanyi 1957, 483)

2. Alternatively, such physical forms, *i.e.*, DNA, brain stems, *etc.*, are part of the biosphere where purpose plays a primary role, unlike the inanimate geosphere of billiard ball physics and mechanics. This line of thought leads back to circular causality (Freeman 1999). While higher order states like consciousness may arise from matter the mechanisms by which they arise and how, once established, sustain themselves remains problematic at best. This is the case only, however, if Design, or *causality by purpose*, is not admitted. Coevolution and coconstruction of increasingly complex forms, rather than linear cause and effect, appear to be primary forces, together with natural selection –from the molecular to the organic to the ideological to the cosmic level (Kauffman 2000).
3. And a meta-methodological dilemma arises if one assumes Design is a special case of Science. I know that I know and it is with this reality that I must deal no matter the epiphenomenal roots of my consciousness, or ‘the ghost in the machine’. Put another way, knowing how I know is not knowing what I know.
4. Hostage to propositional logic, the traditional positivist philosophy of science is based on mechanical physics or billiard ball science. With innovation of quantum physics, however, probability rather than certainty became the test. And here the law of large number comes into play.
5. The law of large numbers was in fact the subject of Edgar Zilsel’s doctoral dissertation (Raven & Krohn 2000, xx). It is, however, as he recognized, not a ‘law of nature’ but rather a mathematical law. As such, Nature’s frequencies need not, and often do not, correspond to expected results. The tension between these two types of laws is what Zilsel called ‘the application problem’ (Raven & Krohn 2000, xxxix). Arguably, it is this fact that led him to reject LPE as non-empirical. In other words, scientific proof lays in putting Nature to the test, not in mathematics and logic, no matter how helpful they may be in the testing process itself. Today this is evident in simulation modeling in all natural & engineering and many social sciences. In effect, a reiterative computer search is made for mathematical formulae that approximate results obtained through the experimental testing of Nature. (Differences in the source and quality of evidence collected in the natural & engineering and the social sciences will be discussed below.) Such simulation models are, of course, examples of Design, *i.e.*, of construction, not reduction.

5.3.3 Science as a Special Case of Design

1. On the other hand, if Science is a special case of Design then there should be not only differences but also commonalities between the two. First, experimental instrumental science is, in fact, an organized and routinized pattern of human behaviour, a recognizable institution that has been called ‘The Republic of Science’ (M. Polany 1962b). This pattern, however, has been routinized only recently in historical terms (about four hundred years) and remains fragile (Kuhn 1996, 167-168). Nonetheless, there is nothing ethnocentric about the experimental method itself. It is now part of the global public domain practiced around the world.

2. This behavioural pattern is in fact so recent that Joseph Henderson in his analysis of the four primary psycho-cultural attitudes - social, religious, aesthetic and philosophic – concludes: “we cannot claim for science... the same epistemological authenticity that we can demonstrate in the four basic cultural attitudes” (Henderson 1984, 77). He suggests, however, that a ‘scientific attitude’ may be emerging as a hybrid of the philosophical attitude “to limit man’s subjectivity to a minimum in observing the nature of man or God” and aesthetic objectivity in “observing nature and man from a significant distance” (Henderson 1984, 77). This aesthetic distancing, in the hands of the German poet Goethe in fact generated an alternative science. Known as ‘Goethean Science’, it is exemplified in his *Theory of Colours* (Goethe 1810) written to refute Newton’s materialistic analysis. The power and intensity of aesthetic observation is succinctly demonstrated therein.

3. Another facet of being a special case of a higher order is evidence of that higher order operating within the special case. Sparkes thus concludes: “pattern recognition is undoubtedly a deeply ingrained human capability, and that it should be used for the kind of information processing which goes on in science seems beyond reasonable doubt” (Sparkes 1972, 41). The repeated use of the terms aesthetics, design, gestalt and intuition by Thomas Kuhn in explaining *The Structure of Scientific Revolutions* is also evidence of the operation of Design within Science itself.

4. In fact there does appear to be a common theory of knowledge in the modern philosophies of biology, science and technology, respectively in the work of Marjorie Grene (1911-), Michael Polanyi (1891–1976) and Martin Heidegger (1889–1976). Their common theory flows from gestalt psychology which, as has been demonstrated, derives from aesthetics and, ultimately from the Design Revolution of the Renaissance. This ‘gestalt knowing’ constitutes a commensurable set of ideas or an ideological commensurability.

5. In the case of Polanyi's philosophy of science, he explicitly claimed to expand gestalt psychology into a theory of knowledge ([M. Polanyi Oct. 1962](#), 605). Even Thomas Kuhn's philosophy of science is gestalt in nature with its paradigms, anomalies and gestalt-switchings. In the case of Grene, gestalt theory is implicit in her view of knowledge as orientation in an environment populated by invariants and affordances. In the case of Heidegger, he claims that the true essence of technology is 'enframing', a word translated from the German *Ge-stell* ([Heidegger 1954](#), 15) and arguably related to *gestalt* meaning "a 'shape', 'configuration', or 'structure'". The fact that all three share this common epistemology may, or may not reflect the fact that Grene studied under Heidegger in the 1930s and later worked with Michael Polanyi in the 1950s (Cohen June 2005).

6. Even the media used by Science – language and mathematics – can be considered Design. It has thus been argued that the nature of the Greek alphabet itself facilitated development of Western thought. Marshall McLuhan, following the lead of his mentor, Harold Innis (1950, 1951) noted that while we recognize the fundamental differences between the perception of literate and preliterate peoples we do not appreciate the impact of different alphabets on perception. McLuhan argued that only phonetically literate man lives in a 'rational' or 'pictorial' space. The discovery or invention of such a cognitive space that is uniform, continuous and connected was an environmental effect of the phonetic alphabet in the sensory life of ancient Greece. This form of rational or pictorial space is an environment that results from no other form of writing, Hebrew, Arabic, or Chinese ([McLuhan and Logan 1977](#)).

7. If a phonetic alphabet creates a rational space in the mind then mathematics surely creates a 'supra-rational' one. In this extreme space only the most rational of hypotheses can be tested. It was, of course, Pythagoras who first recognized a cognate relationship between matter and number and it was this connexion that arguably led LPE to restrict knowledge to propositional terms best expressed in mathematics. From this perspective, language and mathematics are advanced forms of Design with literacy and numeracy being but sophisticated forms of pattern recognition.

8. As Science explores deeper into matter and farther out into space, it continues to discover Design. Fractal mathematics, discovered by Mandelbrot, is a case in point. A fractal denotes a shape that seen from near or far appears the same. Arguably, this confirms the old alchemistic adage: "As Above, So Below". The term entered English in a *Scientific American* article of 1975 in which it was noted:

It seems that mountain relief, islands, lakes, the holes in Appenzeller and Ementhaler cheeses, the craters of the moon, the distribution of stars close to

us in the galaxy and a good deal more can be described by the use of generalized Brownian motions and the idea of the fractal dimension. (OED, *fractal*, n, a)

9. Thus the laws of Nature and of mathematics are, in a sense, examples of Design, of patterns. And in this way, Science is a special case of Design. The human tendency to make and see pattern and order everywhere, however, finds ultimate expression, rightly or wrongly, in ‘The Argument from Design’, an ancient argument for the existence of God:

In its most fresh and innocent form, it went something like this: you can tell by observing the order in the universe that the universe has been designed. This implies the existence of the Designer, whom, as Aquinas said, men call God. According to the wonderful story that this suggested, in the Beginning was the Designer with his Design or Purpose. (Aldrich 1969, 379)

On the more prosaic level of the competition of nations in a global knowledge-based economy, Alfred Marshall noted long ago that: “it is every day more true that it is *the pattern* which sells the things” (*emphasis added*, Marshall 1920; 178).

10. It is important to note in this regard that Science has progressively pushed God further and further out of the picture, in fact beyond the frame. Boyle liberated mechanics and physics; Kant partially liberated biology while, arguably, Kauffman has completed the process by demonstrating the natural chemical tendency of matter to assume increasingly complex forms, ultimately of life itself. Today, the patterns and design of Nature – in both the geosphere and biosphere – can be explained without the assistance of an external agency called God. In the noösphere, however, it may or may not be another question.

5.3.4 Common Ancestor

1. If Science is a special case of Design then the question still remains from whence does it arise? All organisms live in an active environment, enframed by invariants, and faced with affordances - opportunities and dangers – that constantly challenge the organism in its purpose – survival and reproduction. In an environment, all knowledge is orientation relative to such invariants and affordances. Invariants like a picture frame defining one’s field of vision become subsidiary to focused attention on affordances. Many organisms do not, however, simply adapt to the environment. Some actively seek to adapt and modify it to better satisfy their needs, *e.g.*, the ant, bee and beaver. Essentially this involves constructing new invariants, *e.g.*, colonies, hives or lodges.

2. Arguably, the first cell membrane separating and defining an organism from a pervasive outside environment is an example of the innovation of a new invariant: within there is homeostasis and order, without there is chaos. Then a common skin coevolved to enframe

different types of organisms, or cell types, into the collaborative internal organs of multi-organed life forms such as humanity. Arguably, the same is true for ideology. As Arthur Bentley writes in “The Human Skin: Philosophy’s Last Line of Defense”:

“Inner” and “outer” are ever present distinctions, however camouflaged, in philosophical procedure as well as in conventional speech-forms and in the traditional terminology of psychology. What holds “inner” and “outer” apart? The answer must come not by way of transcendental build-up but by indications of pertinent fact. Bluntly the separator is skin; no other appears. (Bentley 1941)

3. Of all organisms on earth, humanity has had the greatest success in structuring its environment. Tools are the means by which humanity animates Nature. They move and change it to suit human purpose. In fact, before art, culture or language, there was tool making. Tools provide *prima facie* evidence of the arrival of our species: artifacts left by our first ancestor, *homo habilis* or the ‘handy man’, some two and a half million years ago (Schuster 1997).

4. Using its opposable thumb, humanity reached out to shape the material world to compensate for its frailty – no great size, no claws or talons and tiny canine teeth. To eat and survive predation, the human brain reached out with finger-thumb coordination to grasp and shape parts of the world into tools with which to then manipulate other parts, *e.g.*, to kill game, plant seeds, build shelters. It appears, from the fossil record, that the opposable thumb preceded and, in a path-dependent manner, contributed to the subsequent and rapid growth and development of the human brain itself.

5. In this regard, the word ‘concept’ derives from the Latin *concupere* ‘to conceive’ that in turn derives from ‘to take’ and, as I understand it, colloquially, meant ‘to grasp firmly with the hand’ or, in Sicilian, ‘to steal’. Thus a concept is a grasping and manipulation of the world – inner or outer – using mental tools, the evolutionary descendants of finger and thumb exercises of prehistoric humanity.

6. Patterning or tooling Nature thus precedes, and I argue, established path dependency leading to symbolic patterning of words and numbers as well as modern technology. As Aldrich observes:

It is with our hands that, fundamentally, we perform as artists in the technological operation. As such, our soul is in our hands. *The eye may guide the hand but, in this case, the seeing is for the sake of the handling.* Technological intelligence does not come to rest in the eye or the ear. Its consummation is in the hand. (Aldrich 1969, 382)

7. Where tools and technology enframe and enable our physical life, ideologies enframe and enable mental life by providing socially agreed conceptual invariants. Traditional examples

are religious inhibitions, prohibitions and taboos. Science can thus be considered as focal attention on affordances (new knowledge) in an environment enframed by subsidiary invariants. These take the form of assumptions used in hypothetical-deduction, or, alternatively, invariants as controlled experimental conditions under which we test cause and effect. In this view, Science by Design provides knowledge as orientation in the noösphere, just as our physical senses provide knowledge as orientation within the biosphere.

8. I have now thrown monotonic knowledge as a noun down the mountain side to acquire mass and momentum becoming a diaphonic verb acquiring knowledge through Science by Design. Plucked whole, the Pythagorean string produces the monotone. Tapped off it produces two tones or the Dyad, the second stage in the Pythagorean *Tetraktys*. The Dyad is not, however, Marxian thesis/antithesis. It is not all black or white. Rather it is a single whole defined by the interaction of its two differing halves. The classical image is the Chinese “*t'ai chi t'u*” or “the supreme ultimate” displayed as a circle curvilinearly divided into the light and dark of yin and yang (Wilhelm 1929, 249). Each half, however, contains the seed of the other - a white dot on black, a black dot on white. In a manner of speaking, two distinct monads, *e.g.*, body and mind, express themselves as one – the individual human being. Similarly, two different ways of knowing – Science & Design – contribute to what we call knowledge. And hopefully, as Kenneth Boulding wrote: “where knowledge is an essential part of the system, knowledge about the system changes the system itself” (1966, 9).

9. Having established a common gestalt-like epistemology across the philosophies of biology, science and technology, as well as aesthetics, economics and psychology, I now turn to the physical form assumed by knowledge. Form, according to Francis Bacon, is “the real or objective conditions on which a sensible quality or body depends for its existence” (OED, *form*, n, 4 c).

6.0 KNOWLEDGE AS FORM

1. Whether generated by Science or Design (efficient cause), knowledge must assume form to exist (formal cause). In summary, I will argue that knowledge takes three forms: personal & tacit, codified and tooled knowledge. These become inputs to the economic process as codified & tooled capital, personal & tacit labour and toolable natural resources. Inputs, in turn, are transformed in production into final knowledge outputs as the Person, the Code and the Tool. Such outputs satisfy the elemental human need to know (material cause). In doing so, I am, however, defying Francis Bacon's warning about erecting new "Idols of the Market-Place" (Bacon 1620). I do so, however, by throwing down lesser ones, ones currently the subject of debate concerning the knowledge-based economy.

6.1 As Form

1. Current public policy debate about the knowledge-based economy focuses primarily on two forms of knowledge: tacit and codified with passing reference to 'local' knowledge which I will subsume under tacit. In this debate, codified knowledge generally refers to knowledge that can be written down, recorded and easily transmitted to others while tacit knowledge cannot be recorded nor easily transmitted to others. 'Local' knowledge refers to that which exists in a specific location such as on the shop floor and which cannot be recorded nor easily transferred to other locations, *e.g.*, team efficiencies and economies (Cambrosio & Keating 1988, 244; Alder 1998).

2. Both codified and tacit knowledge are recognized as factors affecting the production function of the firm and nation-state (OECD 1996; Malhotra 2000; ANSI/GKEC 2001). Both, however, are subject to widely varying and very thin interpretations with significantly different policy implications (Cowan, David & Foray 2000, 212-213).

Indeed, references to 'tacitness' have become a platform used by some economists to launch fresh attacks upon national policies of public subsidization for R&D activities, and equally by other economists to construct novel rationales for governmental funding of science and engineering research and training programs." (Cowan, David & Foray 2000, 212-213)

3. I will now examine the nature and origin of both forms of knowledge – tacit and codified - and add to the mix tooled knowledge by which I mean knowledge fixed in matter as

function. That knowledge can be embedded in matter as function is evidenced by the widespread industrial practice of reverse engineering.

6.1.1 Personal & Tacit Knowledge

1. The term ‘tacit knowledge’ derives from the work of chemist turned philosopher, Michael Polanyi, especially his 1958 book, *Personal Knowledge: Towards a Post-Critical Philosophy* (M. Polanyi 1962a). It should be noted that the 1962 edition is referenced herein. This second edition was published in the same year as Thomas Kuhn’s first edition of *The Structure of Scientific Revolutions* which went through three editions - 1962, 1970 & 1996. While Kuhn makes only one reference to Polanyi, Fuller argues that many of Polanyi’s insights were subsequently and inappropriately attributed to Kuhn. He concludes that “it is not hard to see that Kuhn owed more to Polanyi than the appreciative footnote to his magnum opus, *Personal Knowledge*, would suggest” (Fuller 2000, 140).

2. In fact, between 1950 and 1970, Polanyi published, in addition to his book, some 13 articles defining his philosophy of science and his theory of knowledge (1950, 1952, March 1957, August 1957, 1960-61, 1961, 1962, October 1962, 1965, 1967, 1968, 1969, 1970). Like Kuhn, Polanyi was concerned with defending Science from political and commercial interference. Ideologically, however, he went much further than Kuhn with “The Republic of Science” (1962b) making a direct public policy comparison between the scientific process and the perfectly competitive market of the Standard Model, *i.e.*, let Science do it without interference from government.

3. Polanyi also strongly objected to the received philosophy of science, logical positivism/empiricism (LPE), on two grounds: reality and understanding. For LPE, reality was a metaphysical concept without epistemological content. Polanyi put it this way:

The modern ideal of science is to establish a precise mathematical relationship between the data without acknowledging that if such relationships are of interest to science, it is because they tell us that we have hit upon a feature of reality. My purpose is to bring back the idea of reality and place it at the centre of a theory of scientific enquiry. (M. Polanyi 1967, 177)

4. For Polanyi, “reality in nature is a thing that may yet manifest itself inexhaustibly, far beyond our present ken” (M. Polanyi 1967, 192). It is indeterminacy that defines reality, not certainty. For Polanyi this has significant scientific and philosophical implications:

Modern antimetaphysical philosophies, like pragmatism, operationalism, positivism, and logical positivism, have tried to spell out the implications of asserting a proposition to be true. But if the truth of a proposition lies in its

bearing on reality, which makes its implications indeterminate, then such efforts are foredoomed. They have in fact failed, and must fail, for the indeterminate cannot be spelt out without making it determinate. It can be known in its indeterminate condition only tacitly, by those tacit powers by which we know more than we can tell. (M. Polanyi Oct. 1962, 612)

5. Accordingly, under LPE there can also be no understanding. For Polanyi, however, understanding is taken to include the kind of practical comprehension which is achieved in the successful performance of a skill. This being allowed for, understanding may be recognized as the faculty, cast aside by a positivistic theory of knowledge, which the theory of tacit knowing acknowledges as the central act of knowing. In this sense the practice of skills, the diagnosing of physiognomies, the performance of tests, the use of tools and probes, and the meaningful uttering of denotative words, are so many acts of understanding complex entities. (M. Polanyi Oct. 1962, 605)

6. Polanyi's epistemology is explicitly rooted in gestalt psychology (M. Polanyi Oct. 1962, 605). It is also comprehensive in that "the theory of tacit knowing establishes a continuous transition from the natural sciences to the study of the humanities" (M. Polanyi Oct. 1962, 606). He even proposes a "tacit coefficient" to measure this transition (M. Polanyi Oct. 1962, 605). This led, however, to criticism of tacit knowledge "as psychological, not logical, in character" (M. Polanyi Oct. 1962, 612). This highlights ongoing tension between philosophy and psychology as the preferred path to human knowledge and understanding. As previously noted, Kuhn began with cognitive psychology but this was considered 'metaphysical' by his critics and he retreated to sociology; Polanyi did not retreat.

7. Three central concepts define and delineate Polanyi's ideology: subsidiary/focal knowledge, indwelling and displacement. First, according to Polanyi, we know in an integrated stereoscopic manner invoking a combination of subsidiary and focal knowledge. Thus we know "subsidiarily the particulars of a comprehensive whole when attending focally to the whole which they constitute" (M. Polanyi Oct. 1962, 601). It is subsidiary knowing that is called "*tacit*, so far as we cannot tell what the particulars are, on the awareness of which we rely for attending to the entity comprising them" (M. Polanyi Oct. 1962, 601). In fact, to the degree that we focus on the whole, its parts cannot be known at the same time in themselves. In very gestalt fashion, Polanyi concludes:

We may call the *bearing* which a particular has on the comprehensive entity to which it contributes its *meaning*, and can then say that when we focus our attention wholly on a particular, we *destroy its meaning*. (M. Polanyi Oct. 1962, 601)

Polanyi's focal/subsidiary knowledge can be relationally expressed in aesthetics as figure/ground or melody/note, in Grene's biology as invariant/affordance and, for my purposes, as Science by

Design. Arguably, Polanyi would include all these examples, including my own, as “variants of the same organismic process” (M. Polanyi Oct. 1962, 610).

8. Critically, Polanyi concludes it is

appropriate to extend the meaning of “tacit knowing” to include the integration of subsidiary to focal knowing. The structure of tacit knowing is then the structure of this integrative process, and ... we shall say that, ultimately, all knowledge has the structure of tacit knowledge. (M. Polanyi Oct. 1962, 602)

9. The integrative or constructionist power of tacit knowing, as defined by Polanyi, is also apparent, as previously noted, with respect to the subsidiary or background role played by ideology and technology in our daily lives. If technology *cum* Heidegger (1955) tacitly enframes and enables us as physical beings within a human built environment then ideology (inclusive of religion) tacitly enframes and enables us as mental beings within a network of local, regional, national and global communities of ideas. It is this enframing and enabling of minds within systems of ideas that forms, in part at least, the noösphere.

10. Second, according to Polanyi, the ultimate in tacit knowledge is the human body. Everything we do in, and know of, the world is through our bodies – seeing, hearing, touching, tasting, smelling. The body, however, is normally transparent to the mind in its doings and knowings. This transparency Polanyi calls “indwelling”.

Tacit knowing ... appears as an act of indwelling by which we gain access to a new meaning. When exercising a skill we literally dwell in the innumerable muscular acts which contribute to its purpose, a purpose which constitutes their joint meaning. Therefore, since all understanding is tacit knowing, all understanding is achieved by indwelling. (M. Polanyi Oct. 1962, 606)

11. Indwelling characterizes not just physical performance but also aesthetic distancing and ‘objective’ scientific observation. Polanyi concludes that “it bridges the gap between the I-It and the I-Thou, by rooting them both in the subject’s I-Me awareness of his own body, which represents the highest degree of indwelling” (M. Polanyi Oct. 1962, 606).

12. Third, indwelling has a powerful corollary that Polanyi uses to treat experimental instrumental science: displacement. And it is here that Polanyi meets Heidegger. A characteristic of human being is displacement of sensation from point of contact to distant source. Thus, in the use of a hand tool such as a hammer: “the impact that their handle makes on our hands and fingers is not felt in itself at the place where it happens, but as an impact of our instrument where it hits its object” (M. Polanyi Oct. 1962, 607). This displacement allows humans to indwell in their tools and technology in what I call, existential phenomenology. I will have more to say about this below.

13. Conspicuous by its absence in all of Polanyi's epistemology, however, is any reference to codified knowledge. He treats language but only as an example of tacit knowing. Fixation of semiotic code into material form does not arise anywhere in his work. The opposition, if any in this very dyadic relationship, is between focal and subsidiary knowledge, not tacit and codified.

14. Equally conspicuous by its absence is the term 'personal' in discussion of 'tacit knowledge' in the current debate. It is clear from Polanyi's usage that tacit knowledge is 'personal knowledge'. Put another way, personal knowledge is living knowledge, knowledge fixed in an individual natural person. From whence it comes – demonstration, experience, experimentation, intuition or reading – does not change its personal nature. As will be demonstrated other forms of knowledge – codified and tooled – take on meaning or function only when mediated by a natural person. I therefore insist upon the phrase 'personal & tacit knowledge' to highlight its root in the natural person. If, from time to time, I slip and use 'tacit' alone, I ask the reader to implicitly add 'personal'. This slippage is, as I will argue below, reflective of an ideological bias of the Standard Model of economics that I call 'capitalization of labour'.

15. The question remains, however, what physical form does personal & tacit knowledge take? In fact, it comes in two distinct forms. The first is the matrix of neurons that fix memories (knowledge) as part of one's voluntary wetware, *i.e.*, that part of the nervous system subject to conscious control, specifically, to recall. Memories can usually be described and codified, *i.e.*, spoken and transcribed into language or drawn as a picture.

16. The second are reflexes (part of one's involuntary wetware) composed of "the connected set of nerves concerned in the production of a reflex action" (OED, *reflex*, n, 6 b). Reflexes refer to the memory of our limbs and digits of how to do something, *e.g.*, ride a bicycle. Etymologically it is relevant that the word 'reflex' derives from 'reflect' in the sense of 'to remember'. Knowledge is fixed in one's body parts and nervous system. This may be the fine practiced motor skills of a brain surgeon or those of a professional bricklayer. What they share is that such knowledge is tacit, *i.e.*, not subject to articulation and codification - spoken, transcribed or drawn. It can, however, sometimes be transferred through demonstration, repetition and practice.

17. Ultimately, all knowledge is personal & tacit. A Code or a Tool always leads back to a Person acting as agent to decode or activate it. Personal & tacit knowledge is also one-dimensional, a monad: it is known by only one mind. It is the sum of what an individual knows. If one is what one knows then personal & tacit knowledge is the definition of the individual

human being. And, only the individual can ‘know’. Books and computers do not know that they know, nor does any other species on this planet. Companies, corporations and governments or, in Common Law, ‘legal persons’ cannot know (Graf 1957). Only the solitary flesh and blood ‘natural person’ can know.

6.1.2 Codified Knowledge

1. Codified knowledge, as a term, does not have a seminal authorial source. Rather it refers to the encoding of knowledge in written language, symbols (including mathematical symbols), sounds or pictures. In effect, the knowledge of one person is fixed in a communications medium then subsequently – distant in Time and/or Space – is decoded and assimilated by another human mind into personal & tacit knowledge. It is thus extra-somatic knowledge (Sagan 1972) acting as “a completely new ‘genetic’ system dependent on cultural transmission” (Waddington 1960, 149).
2. Codified knowledge is semiotic in nature, *i.e.*, conveyed in signs and symbols. As noted by Husserl, writing, and codified knowledge in general, “makes communications possible without immediate or mediate personal address; it is, so to speak, communication become virtual. Through this, the communalization of man is lifted to a new level” (quoted in Idhe 1991, 46). In this sense, codified knowledge is two-dimensional engaging two minds – the author and a distant reader/receiver. Such knowledge, however, begins and ends as personal & tacit knowledge within the human mind.
3. There are four qualifications to this definition. First, speech or oral language is codified knowledge. Oral or pre-literate cultures, as will be seen, create and maintain knowledge through the mnemonics of chant, incantation, poetry and fable. In general, however, I ignore spoken language unless fixed in material form, *i.e.*, recorded in a material matrix - written or otherwise.
4. Second, codified knowledge is restricted to ‘human-readable’ (analogue) code. I therefore exclude machine-readable (digital) code including machine/molecule-readable versions of the genomic ‘code of life’ or the “autobiography of a species” (Ridley 1999). The distinction is between semiotic or symbolic knowledge communicated from one human mind to another *versus* the operating instructions of a machine or a molecule. As will be seen, machine/molecule-readable code is a form of ‘soft-tooled’ knowledge.
5. Third, my focus is primarily on the matrix or communications medium into which knowledge is fixed rather than its content. In this sense, to paraphrase McLuhan, ‘the matrix is the message.’ Beginning with the telegraph then the photograph, telephone, sound and video

recording, the number and form of communication media has exploded since the 19th century and continues to do so. In effect, there has been an avalanche of speciation of communication technologies.

6. Fourth, codified knowledge is both an intermediate good, *i.e.*, an input to the production process, and a final consumption good, *e.g.*, as books, magazines, motion picture, reports and sound recordings. Machine-readable code is always an intermediate and never a final output of the knowledge-based economy. Human-readable code can be either.

7. In effect, codified knowledge consists of four overlapping levels. The first is the personal knowledge of the author. The second is the semiotic code itself – alphabet, icons, pictographs, pictures, sounds, *etc.* into which knowledge is translated. The third is the material matrix or communications medium into which knowledge is fixed and then transmitted for decoding by another human mind – the reader/receiver. Each has epistemological and legal implications. In codified knowledge ideology meets technology. Code structures ideas and their expression while the matrix structures how we send and receive knowledge from others. I will now consider some of the epistemic implications of Code and the changing nature of its matrix as revealed by three sets of authors.

6.1.2.1 Innis, McLuhan & *Réalism fantastique*

1. Through his study of communications, Harold Innis identified a fundamental relationship between a culture and its dominant communications matrix (Innis 1950, 1951). According to Innis, a civilization is limited in space, but extensive in time, *i.e.* it has duration, to the extent its matrix is durable, *e.g.*, stone, clay or parchment. Alternatively, it is extensive in space, but limited in time, to the extent its communications matrix is non-durable but easily transported, *e.g.*, papyrus and paper. Using this hypothesis Innis explained the rise and fall of empires. Five examples will demonstrate Innis' style of inductive analysis.

2. First, acid-based paper is cheap and light weight and has been used for about 150 years. This corresponds roughly to the 19th century European colonial expansion. Books, newspapers, periodicals and other records fixed in this medium are, however, now disintegrating in libraries and archives around the world (*The Economist*, February 27, 1987: B-1). Meanwhile, parchment and vellum from the thirteenth century have not 'self-destructed'. This implies that the European colonial empires would be short-lived in Time because the dominant communications medium was light and easily transportable. In fact, the British Empire 'on which the Sun never

set' was, in historical terms, the most extensive in space, but also one of the shortest empires in duration.

3. Second, the dominant communications medium today, leaving aside for the moment the Internet, is television that spans the world in an instant, *i.e.* it is extensive in Space. Television takes the average citizen around the world to spaces and places of which his ancestors never knew. A question, however, has arisen about television's impact on attention span. Some argue that children do not read as well as before because attention span has been reduced by TV, *i.e.* the medium, while extensive in Space, has reduced the psychological duration of Time.

4. Third, new communications technologies have arguably made the entertainment industry the largest sector of final demand in the knowledge-based economy. But this industry is peculiar in a number of ways:

(a) its hardware including direct broadcast satellites, fiber optics, magnetic recording technologies, and the compact disc player are based upon aluminum, silicon and iron oxide, *i.e.*, stone, that, theoretically, should endure more than a century. On the other hand, content, such as television programs, circle the globe in an instant;

(b) production of the medium is separated from production of the message. Thus "home entertainment" hardware is dominated by Asian producers while programming is dominated by the American entertainment industry, *i.e.*, Hollywood. This international division of labour - medium from message - suggests a new culture unlike any in history, *i.e.*, a global culture; and,

(c) like previous communications revolutions, *e.g.*, the printing press, the new communications media is being accompanied by a breakdown of old ways of communicating, *e.g.*, declining literacy, and a heightened sense of societal "dis-ease".

5. Fourth, behind the scenes lurks a new nervous system, a new communications matrix, encircling planet Earth – the World Wide Web, the WWW or 'the Web'. In less than a decade, the Web has affected business, economics, education, entertainment, health care, information, news and the nature of work itself. Among the many characteristics of the Web, consider three:

(a) the Web is economically bifurcated into intermediate and final knowledge goods and services. For example, the 'consumer' Internet is paralleled by the 'B2B' or the business-to-business Internet that globally links producers and suppliers with significant cost reductions for firms. In effect, it has reduced transactions costs of doing business (Coase 1992) and shifted the borderline between the firm and the marketplace, *e.g.*, outsourcing;

(b) mechanical and electronic devices are increasingly being plugged into the Web. From automobiles, ships, trucks and trains to home air conditioning, computers, heating, lighting and security systems to microwave ovens, refrigerators, toasters, toilets and TV sets all are now being attached to the Web permitting two-way communication not just between people but also between machines. The Web therefore carries both human-readable and machine-readable code; and,

(c) creation, distribution and duplication costs on the WWW approach zero raising questions about copyright and facilitating new forms of authorship as noted by copyright lawyer David Nimmers (1998, 521-522).

6. Fifth, and finally, contemporary recording technologies provide artists, celebrities and 'historic' events with something that only literary and visual artists enjoyed in the past - life after death. This is a life not as a ghost on another plane, but as a shadow on the silver screen. There may never again be a Richard Burton, but his image, his voice, his body language and his performance will now endure like the plays of Shakespeare, part of our social genetic, the extra-somatic knowledge that is the stuff of culture. This link with the past, or *re-ligio*, distinguishes the Arts from other knowledge domains. In the natural & engineering sciences, for example, Kuhn observed that normal science has, in effect, no history at all. Everything so to speak is 'new' (Kuhn 1996). In the Arts, however, the images and words of cultures and civilizations long buried by the sands of time enrich and inspire contemporary creators (Boulding July 1986).

7. Innis' colleague, Marshall McLuhan, extended the linkage between medium of communication and duration of civilization with his aphorism "The Medium is the Message". McLuhan recognized that the material matrix affects both reception of the message and the fabric of society itself. From the hot, focused matrix of the printing press with its linear phonetic alphabet (the first engine of mass production) to the cool, passive medium of television with its cascade of images and sounds, McLuhan believed a major transformation in consciousness, of knowing, is underway: "the transition to the electronic phase of simultaneous or acoustic man" (McLuhan 1978).

8. A similar conclusion was reached in France by Pauwels and Bergier with their 1960 publication of *Les matin de magician* (*The Morning of the Magicians*). This text began a new strain in French philosophy, or rather metaphysics, called *réalisme fantastique* (fantastic realism). Its sense is: "Can you believe what some people really believe!" Beginning with what the Nazi did, Pauwels and Bergier asked what did they think they were doing? The answer tore at the roots of European rationalism. The earth is not round, nor is it flat, but rather it is a

crucible with the Chinese and Europeans held to their respective sides of the planet by solar radiation. The earth has had many moons and with each a great race arose but in the dark between moons inferior races were spawned, the people of Zog. How could the leadership of arguably the most advanced nation in Europe believe such things in the twentieth century? The alarming answer, of course, is they did! The need to know can be satisfied in many ways, not all are rational and in the competitiveness of nations in a global knowledge-based economy one must never forget this fact of life.

9. With respect to the world of the 1960s, Pauwel and Bergier concluded that exposure of children to vastly expanded audio-visual examples of life role models and opportunities coded in motion pictures, radio and television programs would engender a psychic mutation reminiscent of McLuhan's "simultaneous or acoustic man". Their final chapter is in fact entitled *Reverie sur les mutants*, or dreams about the mutants (Pauwel & Bergier 1960, 607).

10. A 'simultaneous or acoustic' mind is not the focused linear consciousness of the previous literate or textual mind. Where the literate mind acts like the eye focusing on detail, the acoustic mind is an ambient consciousness awash in images and sounds and aware of context, gestalt and pattern. The addition of moving images and recorded sounds to the stock of codified knowledge has brought, according to McLuhan, pattern recognition to the foreground of contemporary consciousness. This was recently highlighted in Congressional testimony by the U.S. Defense Secretary, Donald Rumsfeld, when he contrasted the psychological effect of seeing pictures of prisoner abuse at Iraq's Abu Ghraib prison in May 2004 compared to reading the file in January (Rumsfeld 2004).

11. Three examples demonstrate the 'iconic' effects of the new communications matrix and its cybercode. First is invention of the computer icon, the window and the mouse by scientists at Xerox Park in the early 1980s. The shift from text to graphics in Western culture arguably began with the Xerox's computer 'icon'. They also introduced 'WYSIWYG' as the standard, *i.e.*, what you see on the computer screen is what you get out of the printer. A user interacts more effectively by gestalt-like icons than by the temporal linearity of text. While Xerox failed to exploit its inventions, they were picked up first by Apple Computers and then by Microsoft. Second is the transition in 1990 from the Internet (text-based) to the World-Wide Web (graphic-based) with the first graphic 'browser'.

In a mere decade, strands of 'The Web' have been spun out from a handful of obscure physics labs into seven million Web sites and tens of millions of workplaces and homes around the world. It has catapulted the high-technology industry to unimagined heights, given meteoric rise to electronic commerce, revolutionized research, and made phrases such as 'download'

and 'home page' part of everyday conversation. (*Ottawa Citizen*, December 24, 2000)

12. Third was the launch of Windows '95 with its shift from a text-based DOS to a graphics interface. Home and office computing took off. In short order, Microsoft became one of the largest business enterprises in the world and Bill Gates, the world's richest man. It must be noted, however, that there has been a 'Kuhnian loss' in transition (Fuller 1992, 272). Much of the new media does not require literacy and with the cultural shift to acoustic space there has been a decline in attention span and literacy, as noted above.

6.1.2.2 Thomas Shales & the Re-Decade

1. Perhaps the most succinct statement of the impact of new forms of codified knowledge is by cultural critic Thomas Shales in his 1986 *Esquire* article "The ReDecade". Through the new recording technologies, especially video, consumers now have nearly universal visual access to the styles and tastes of all historic periods, as presented on television and in motion pictures. Does one want to watch gangster movies or musicals of 1930s or witness the French Revolution or Moses on the mountain? Does one want to replay it, time after time, or erase it to capture images and sounds of another Time and Space?

2. This access to the fashions and styles of all historic periods produced what Shales called the ReDecade, a decade without a distinctive style of its own, a decade characterized by the pervasive stylistic presence of all previous periods of history. The impact of this phenomenon on consumer behavior is, at least in the short term, confusion and disorientation. Time has become a significant dimension of consumer behavior, and, more importantly, of self-consciousness. As noted by Shales:

It does seem obvious that here in the ReDecade ... the possibilities for becoming disoriented in time are greater than they have ever been before. And there's another thing that's greater than it has ever been before: accessibility of our former selves, of moving pictures of us and the world as we and it were five, ten, fifteen years ago. No citizens of any other century have ever been provided so many views of themselves as individuals or as a society. (Shales, 1986: 72)

3. As a prequel, art critic Robert Hughes, in his book and television program *The Shock of the New* (1981) pointed out that since the turn of the twentieth century modern abstract art has been increasingly concerned with the fourth dimension, Time, in contrast with the traditional dimensions of Space and perspective. Thus abstract painting may be viewed as a precursor to the increasing disorientation in Time characteristic of the ReDecade.

4. It is not yet clear what will be the long term impact of the ReDecade on consumer behavior. It is likely, however, that there will be a growing market for historic fashions, period piece furniture and reproductions as well as other cultural durables from all historical human cultures. In effect, Shales' *ReDecade* is an "overlapping temporal gestalten" (Emery & Trist 1972, 24), *i.e.*, the Present is an amalgam of anachronisms of the Past, and, given the contemporary prominence of science fiction, of the Future. Durable goods, however, constitute a different form of knowledge – tooled knowledge to be discussed below.

6.1.2.3 William Gibson & Cybercode

1. Two years before Thomas Shales published "ReDecade", William Gibson (1984) published his first novel, *Neuromancer*. This Hugo Prize winning science fiction novel changed the way the computer/communications industry saw itself and the way the public saw the industry. This was eleven years before Windows '95. Using a manual typewriter Gibson coined the term 'cyberspace' and created a prescient vision of what would become the Web. With his text Gibson created a new literary genre: 'cybergothic'. For my purposes, however, he defined 'cybercode' - including text, graphic icons, sounds and moving holographic images that have been, or shortly will be, codified on the Web. Gibson extended this vision with *Count Zero* (1986), *Mona Lisa Overdrive* (1988) and *Virtual Light* (1993). His most recent novel, however, is *Pattern Recognition* (2003). Set in the present, it is not science fiction but rather a novel about contemporary 'cool hunting', mysterious 'footage' on the Web and the global design and marketing industry. Again, Gibson addresses Code, but this time fashion code.

2. My subsequent text will be punctuated with references to Gibson's vision of cybercode and his futuristic projections about intellectual property. In the global knowledge-based economy Gibson's vision is *film noir*, not documentary. Nonetheless, it portends a possible future. From a Canadian perspective, I see Gibson as the new McLuhan of codified knowledge. For now, however, I turn to tooled knowledge, *i.e.*, knowledge fixed as function in a material extra-somatic matrix.

6.1.3 Tooled Knowledge

1. The term 'tooled knowledge' is not currently part of the debate about the knowledge-based economy. The term itself appears in the classic *The History of Economic Analysis*, wherein Joseph Schumpeter refers to economics as "a recognized field of tooled knowledge" (Schumpeter 1954, 143). It is in this sense that a former professor, Giles Paquet, called economists tool-bearing animals with their heads as toolboxes. My usage, however, will be

quite different. I will be dealing not with the manipulation of ideas (ideology) but rather with knowledge tooled into matter, knowledge embodied as physical functioning things (technology).

2. My usage will also be different from that in the philosophy of technology including Baird's 'thing knowledge' (Baird 2004) and Idhe's 'instrumental realism' (Idhe 1991). My focus is economics, *i.e.*, satisfying the unlimited human want, need and desire to know with limited means. Its objective lens is the final consumer, not the scientist, technologist or instrument-maker. In common with the philosophy of technology, however, tooled knowledge is three-dimensional connecting one mind to another through the hands, *e.g.*, through reverse engineering. This is in keeping with Aldrich's observation that: "technological intelligence does not come to rest in the eye or the ear. Its consummation is in the hand" (Aldrich 1969, 382).

3. I restrict myself to works of technological rather than aesthetic intelligence because aesthetic works are semiotic or symbolic in nature intended to be decoded by another human mind. Tooled knowledge, on the other hand, is functional taking two-related forms: 'hard-tooled' and 'soft-tooled'. Hard-tooled knowledge breaks out into three types: sensors, tools and toys. Soft-tooled breaks out into four: computer and genomic code, mathematics, standards and techniques.

4. Before describing each I need expand on the relation between knowledge and technology. I draw my introduction from Michael Polanyi and my main argument from Heidegger. For Polanyi, tools, and technology in general, are extensions of our bodies "forming part of ourselves, the operating persons. We pour ourselves into them and assimilate them as parts of our own existence" (M. Polanyi 1962a, 59).

5. For Heidegger, technology (or tooled knowledge) is how the human ecology is enframed and its members enabled. As a species, we order things in our environment into standby mode as a 'standing-reserve' (Heidegger 1955, 17) awaiting activation – the furnace, TV, computer, car, train, airport, *etc.* Whatever is part of this standing-reserve "no longer stands over against us as object" (Heidegger 1955, 17). It is no longer 'other'. It becomes an existential phenomenological extension of human being. Like ideology, technology becomes subsidiary or tacit, present but in the background, out of focal consciousness, yet ready at hand. And, like Polanyi in 1958, Heidegger used the hammer as the quintessential example some thirty years earlier in his *Sein und Zeit* (Being & Time) published in 1927.

6. Heidegger's interpretation of Aristotelian causality is also radically different from the conventional deriving from Latin translation rather than Greek original. Thus 'cause' derives from the Latin verb *cadere*, "to fall," meaning "that which brings it about that something falls

out as a result in such and such a way” (Heidegger 1955, 7). The original Greek, *aition*, however, means “that to which something else is indebted” (Heidegger 1955, 7). For Heidegger the four causes – material, formal, efficient and final - are “all belonging at once to each other, of being responsible for something else” (Heidegger 1955, 7). This is similar to Kant’s view of living things in which “each part is reciprocally means and end to every other” (Greene & Depew 2004, 94). In biology, the “something else” is a living entity with natural purpose; in the case of technology, it is an artifact imbued with human purpose.

7. Similarly, Heidegger interprets final cause, or *telos*, in an unconventional manner. Usually translated as ‘aim’ or ‘purpose’, he argues *telos* originally meant in the Greek that “which gives bounds, that which completes” (Heidegger 1955, 7). For Heidegger, technology thus represents “modes of occasioning” in which all four causes are at play “bringing-forth” something - natural or human-made – to completion (Heidegger 1955, 10). And it is “through bringing-forth, [that] the growing things of nature as well as whatever is completed through the crafts and the arts come at any given time to their appearance” (Heidegger 1955, 10). This is reminiscent of Kauffman’s ‘adjacent possible’ (2000). I now turn to the hard and soft appearance of tooled knowledge.

6.1.3.1 *Hard-Tooled*

1. By ‘hard’ I mean tooled knowledge as a physical artifact designed to:

- monitor the world of matter and energy (a sensor) or;
- manipulate, shape or animate matter and energy (a tool or toy).

2. In summary, the purpose of sensors is measurement; the purpose of tools is manipulation; and, the purpose of toys is pleasure. Sensors and tools are located on the production-side of the economic equation; toys, on the consumption-side. Sensors and tools are utilitarian, *i.e.*, they serve a higher purpose; toys are non-utilitarian, *i.e.*, they have no purpose other than themselves. Collectively, sensors, tools and toys constitute ‘instruments’.

3. Another distinction must be made between ‘wetware’ and ‘dryware’. Living things can, using genomics or traditional cross-breeding, be designed to serve a utilitarian purpose, *e.g.*, gene therapy (BBC News April 2002), or, a non-utilitarian one, *e.g.*, genetically engineered fish that glow in the dark (Shaikh 2002). These constitute wetware, *i.e.*, ‘living’ tooled knowledge. Traditional instruments are constructed out of inanimate matter, usually minerals, and constitute dryware. Both, however, are hard-tooled knowledge. Using this distinction, plastics are a cross-over, *i.e.*, they are organically-based but generally derived from non-living sources, *e.g.*,

petroleum. The borderline between wetware and dryware is becoming increasingly obscure as the sciences of genomics, proteomics and nanotechnology mature. Thus, in theory, the genetic code used by marine organisms to produce biosilicate shells may eventually be used to make silicon chips for computers.

4. The three – sensors, tools and toys – can, from time to time, be one and the same. For example, a sensor may be active or passive. An active sensor monitors changes in nature by initiating such changes, *e.g.*, a synchrotron or subatomic particle accelerator. Thereby the sensor becomes a tool. Furthermore, to the degree that *normal science* involves *puzzle solving* (Kuhn 1996, 35-42) then scientific instruments can, with no disrespect, be considered playthings or toys of scientists. Play-like behaviour is a generally recognized characteristic of creativity in all knowledge domains. In this regard, the search for knowledge-for-knowledge-sake is non-utilitarian, *i.e.*, it has no objective other than itself. To this extent, all scientific instruments can be considered toys. In effect, scientific instruments are designed to produce new knowledge which, to the scientist, is like the pleasure of a toy. As will be seen, this relates to the subordination of Sensation to Reason as in Timothy Findley’s “intellectual priapism” (Findley 1999, 258).

5. Similarly, new scientific instruments – the foundation of experimental research – may subsequently become industrial tools, *e.g.*, the scanning electron microscope, ion implantation and the synchrotron (Brooks 1994, 480). They may also become toys intended for amusement or entertainment, *e.g.*, the cathode display tube developed to monitor laboratory experiments became a standardized tool of science and industry and then the television set in the family room.

Sensors

1. As a sensor or ‘probe’ (M. Polanyi 1962a, 55), tooled knowledge extends human touch, taste, sight, sound and smell. It monitors the world of matter and energy above (macroscopic), at (mesoscopic), or below (microscopic) the threshold of our natural senses. The resulting ‘readings’, when organized, structured and systematized, become codified knowledge that can be shared as a statement of objective, empirical fact.

2. To the degree they measure above and below the threshold of our natural senses, scientific instruments realize a Platonic ideal: “belief in a realm of entities, access to which requires mental powers that transcend sense perception” (Fuller 2000, 69). Furthermore, the

'language' of sensors realizes the Pythagorean ideal by reporting Nature by the numbers. My term 'sensor' corresponds to Baird's 'measuring instruments' (Baird 2004).

3. The effects of sensors can be profound, for example: "the idea of a world governed by precise mathematical laws was transmitted... through Galileo's and Huygen's conversion of the mechanical clock into an instrument of precision" (Layton 1974, 36). Or, consider the impact on our "image" of the world (Boulding 1956) of Galileo's innovative use of the telescope resulting in "artificial revelation" (Price 1984, 9).

4. To the degree that the natural sciences are about acquiring knowledge of the physical world then, to that degree, all scientific instruments are sensors, *i.e.* their primary purpose is to monitor, not manipulate. That scientific instruments embody knowledge is noted by Shapin who reports:

much empirical work has addressed the embodied nature of scientific know-how and the embodied vectors by which it travels, whether that embodiment is reposed in skilled people, in scientific instruments, or in the transactions between people and knowledge-making devices. (Shapin 1995, 306)

With respect to the later, he notes the emergence of new non-human actors including cyborgs – part human and part machine (Shapin 1995, 313).

5. The history, philosophy and sociology of science are replete with allusions to scientific instruments. Experimental science was, is now, and probably always will be, rooted in such tooled knowledge (Price 1984). For example, CERN's Large Hadron Collider will begin operation in 2006 while the recently upgraded Fermi National Accelerator Lab's "Tevatron" is already sensing Nature at levels beyond the sensitivity of previous instruments. The 'Canadian Light Source' synchrotron at the University of Saskatchewan is an example of increasingly common sensor/tool crossovers serving both research science and industry. These are 'Big Science'. The size and complexity of such instruments, the range and diversity of knowledge embodied and costs associated with their design, construction and operation may limit future revolutions in physics (Fuller 1992, 252). Without doubt, they impose a strong path dependency on the road to future knowledge (Rosenberg 1994, 1-6).

6. It has also been argued that new sub-disciplines, *i.e.*, new categories of knowledge, within the natural sciences and related technological disciplines emerge in response to new instruments (Price 1984). This conclusion is reinforced by Rosenberg's findings about their interdisciplinary impact in bringing together scientists from different disciplines and thereby mitigating incommensurability (Rosenberg 1994, 156).

7. Beyond the knowledge embodied in scientific sensors and the new knowledge they produce, their epistemological importance lays in consistent objective evidence about the state of the physical world. Such evidence is objective in the sense that collection is not mediated by a human subject. Instruments extend the human senses beyond the subjectivity of the individual observer. Once calibrated and set in motion a clock – atomic or otherwise – ticks at a constant rate per unit time until its energy source is exhausted. Again, such measurement is ideally achieved without mediation by a human subject.

8. In this regard it is important to note that sensors pattern the modern way of life. The simple household thermometer is an example. It tells us when we have a fever and when to seek medical intervention. In turn, a medical thermometer is used to monitor the progress of such intervention (Shapin 1995, 306-307). Put another way:

By encapsulating knowledge in our measuring instruments, these methods minimize the role of human reflection in judgment. They offer a kind of “push-button objectivity” where we trust a device and not human judgment. How many people check their arithmetic calculations with an electronic calculator?... Putting our faith in “the objectivity” of machines instead of human analysis and judgment has ramifications far and wide. It is a qualitatively different experience to give birth with an array of electronic monitors. It is a qualitatively different experience to teach when student evaluations – “customer satisfaction survey instruments” - are used to evaluate one’s teaching. It is a qualitatively different experience to make steel “by the numbers,” the numbers being provided by analytical instrumentation. (Baird 2004, 19)

Tools

1. If sensors extend the human senses then tools extend the human grasp. Tools are designed with human purpose. They have an in-built aim, *i.e.*, they are teleological (Layton 1988, 90-91). We thus recognize a tool by its purpose (M. Polanyi 1962a, 56). Put another way, a tool is created when “a function couples purpose with the crafting of a phenomenon. A function is a purposeful phenomenon” (Baird 2004, 123).

2. The teleological nature of tooled knowledge is, in a sense, atavistic, an epistemological throwback to medieval animism, *i.e.*, when objects and natural phenomena were believed possessed of soul. This was generally displaced by mechanistic causality, the *episteme* of the first Scientific Revolution of the mid-17th century (Foucault 1973). This provided a “description of reality in terms of a world of precision, free of all considerations based upon value-concepts, such as perfection, harmony, meaning, and aim” (Layton 1988, 90). While this displacement is appropriate in the geosphere, it is inappropriate in the world of human-made things where “the sciences of the artificial” rule (Herbert Simon quoted in Layton 1988, 91).

3. Purpose is inherent in a tool. It is designed to do a job; it is not valued in-and-of-itself like a work of art, but rather for what and how well it can do that job. The knowledge to make a tool becomes embedded in it. It becomes tooled knowledge. If intended to do a job in the weightlessness of outer space then its shape, size and tolerances will be different than if designed to do the same job under terrestrial gravity or the enormous pressures of the ocean's depths. Put another way: "Material agency is revealed in our mechanical contrivances... Much as we control concepts through the exercise of our literary skills, we control material agency through the exercise of our making skills" (Baird 2004, 47).

4. Tools are located on the production-side of the economic equation. They are intermediate goods used to produce final goods and services purchased by consumers (excepting the handyman). They are utilitarian - valued for what they can do, not for what they are in-and-of-themselves.

5. A final distinction must be drawn between specific purpose and general purpose tools, or what David calls 'general purpose engines' (David 1990). A specific purpose tool has but one purpose, *e.g.*, a hammer or a drill press. A general purpose tool has multiple applications which "give rise to network externality effects of various kinds, and so make issues of compatibility standardization important for business strategy and public policy" (David 1990, 356). Modern general purpose tools also generate "techno-economic regimes" involving a web of related installations and services. Such is the case, for example, with the internal combustion engine. When embodied in an automobile it requires manufacturing plants, refineries, service stations, parking lots, car dealerships, roads, insurance, *et al.* In temporal succession, general purpose tools include the printing press, steam engine, electric dynamo, internal combustion engine, radio-television, the computer and genomics.

6. Such techno-economic regimes display path dependency. Specifically, once introduced all subsequent additions, changes and/or improvements to a general purpose tool must conform to existing standards. The example of 110 versus 220 voltage used in North America and Europe, respectively, is a case in point. Any electric appliance – new or old – must be tooled to operate using the appropriate current; otherwise it will not function.

Toys

1. If sensors are for measuring and tools are for manipulating then toys are for pleasure. Sensors and tools are located on the production-side of the economic equation. They serve as inputs in the production of final goods and services. In the case of sensors, monitoring

information may be used either as an input to the production of knowledge or the production of other goods and services. Toys are final goods and services. They are appreciated for their own sake, not for any contribution to the production of other things. In this sense, toys are non-utilitarian, pleasure-giving devices. This includes the pleasure of learning, *i.e.*, knowledge as a final consumption good. It also includes the aesthetic experience of works of art. They are appreciated for their own sake; they are physical artifacts that embody the knowledge of the artist in making an artwork 'work'. I am, however, compelled to use the word 'toy' because is no other word in English denoting a work valued in-and-of-itself with no other purpose or utilitarian value. One plays with a toy; one works with a tool.

2. If, *cum* Bentham, pleasure is the only objective of life then tooled knowledge, like personal & tacit and codified knowledge, reflects the full spectrum of human wants, needs and desires subject to cultural, legal and financial constraints. Aesthetic distancing, morality and scientific objectivity are not epistemological constraints in economics. As toys, tooled knowledge has extended the human playpen to the globe and beyond; it has extended our sense of time and place beyond the dreams of previous generations. In this sense, it is 'natural' that one of the first adapters of new computer/communications technologies such as the video recorder and the WWW was, is and will be the sex or 'XXX' industry.

6.1.3.2 Soft-Tooled

1. An instrument, as a physical artifact, must be activated by a human operator if it is to fulfill its function. Operation of an instrument – sensor, tool or toy – is generally associated with tacit and/or codified knowledge in the form of computer and genomic programs, mathematics, standards and techniques. In summary, computer programs are machine-readable code used to operate instruments – sensors, tools and toys. Genomic programs are molecular/machine code read by machines to analyze and/or synthesize biological compounds and living organisms (Hood 2002). Standards are codified knowledge physically designed *into* an instrument defining its operational properties, *e.g.*, a 110 or 220 volt electric razor. Mathematics is the language in which such standards are usually set and in which most instruments are calibrated. Techniques are personal & tacit knowledge required if use and application of an instrument is to attain the intended purpose.

2. Soft-tooled knowledge is tied to hardware. In effect, one has no purpose (*e.g.*, software) and one has no function (*e.g.*, hardware) without the other. Soft-tooled knowledge exists on both sides of the economic equation – consumption and production.

Computer & Genomic Programs

1. The purpose of tooled knowledge is manipulation of the natural world. A computer program, while codified and fixed in a communications medium, is intended to be decoded by a machine not by a human mind. It is intended to manipulate the flow of electrons in a circuit. In turn, such circuits may activate other machines and/or machine parts, *e.g.*, industrial robots in steel mills, auto plants and fabricating industries. The distinction between ‘machine readable’ and ‘human readable’ fuelled the 1970s debate about software copyright (Keyes & Brunet 1977). Recognition of software copyright in 1988 was a break with a long legal tradition restricting copyright to ‘artistic works’ (Chartrand 1997a). For my purposes, this distinguishes computer programs as soft-tooled, *i.e.*, machine-readable rather than human-readable knowledge.

2 Similarly, a genomics program, while codified and fixed in a communications medium, is intended to be decoded by machines and molecules, not by a human mind. It is intended to manipulate the chemical bonds of atoms and molecules to analyze or synthesize biological compounds and living organisms with intended or designed characteristics. Such code is being used in a rapidly increasing range of scientific instruments (Hood 2002). Compared to the cost of ‘Big Science’ in physics, however, instrumentation costs in genomics remain relatively low while instrument capabilities are accelerating rapidly.

3 As with software copyright, legal questions are arising about genomic copyright. There are two levels of concern. First, copyright logically adheres to genomic databases as documentation - hard-copy, electronic or fixed in any future matrix. Second, copyright may, or may not, be determined by the courts to adhere to gene segments themselves. The question in law is originality. Naturally occurring sequences, according to some, are facts of nature and hence copyright cannot adhere. In the case of original sequences, however, *i.e.*, artificial, there appears no reason for copyright not to adhere as they do with computer programs. Whether this is appropriate is another question.

4. Genomic programs, however, involve not just sensors and tools but also toys. In the fine arts, one author - David Lindsay (Lindsay 1997) - has tried to copyright his own DNA with the U.S. Copyright Office (without success) and mounted a web page: “[The Genome Copyright Project](#)”. Since his initial effort in 1997 a private firm - the [DNA Copyright Institute](#) – has appeared on the world-wide web (DNA Copyright Institute 2001). It claims to: “provide a scientific and legal forum for discussion and research, as well as access to valid DNA Profiles, among other Services, as a potential legal tool for deterrence and resolution of situations where there is suspected DNA theft and misappropriation.”

5. Steve Tomasula speculatively writes about the rabbit Alba, the first mammal genetically engineered as a work of art in “[Genetic Arts and the Aesthetics of Biology](#)” (Tomasula 2002). He compares incipient gene artists with [Marcel Deschamp](#) (1887-1968). While the above remain speculative, the fact is that Mike Manwaring, a graduate student at the University of Utah created the first piece of genetic art in 2002: a version of the Olympic Rings entitled “the living rings” made from nerve cells (BBC News On-Line, January 15, 2002). And at least one geneticist, Willem Stemmer, vice president for research and development at Maxygen, has considered transposing genomic code into music to create ‘DNA ditties’ and thereby gain copyright protection (Fountain 2002).

Mathematics

1. The Pythagorean concept of a cognate relationship between mathematics and the physical world is, perhaps, the single most important inheritance from the ancient world reflected in the material well being of contemporary society. It finds fullest expression in ‘the calculus’, *i.e.*, the mathematics of motion and change through Time. The following is a short history of its development. As will be seen, the ability of a knowledge domain and/or its component disciplines to achieve mathematical articulation tends to raise its epistemological status from a Mechanical to a Liberal Art.

2. If the computer represents a ‘general purpose engine’ ([David 1990](#)) then mathematics is a general purpose concept, *i.e.*, a mental general purpose tool. It serves as the most effective interface yet discovered (or invented) between mind and matter, between user and instrument, between human readable and machine-readable forms of expression. In this regard, it is important to remember that music was the only ‘fine art’ admitted to the classical and medieval Liberal Arts curriculum. Balance, harmony, proportion and resonance are critical mathematical elements that Pythagoras expressed with the music of a string – halves, quarters, thirds, fourths, fifths, etc. All are audible properties of a string. The conceptual metaphor is one employed in a number of disciplines. For example, in cosmology, Jeff Weeks recently explained fluctuations in readings about the physical dimensions of the universe by comparing them with the sound waves of musical harmonics (Roberts 2004).

3. For the ancient Greeks (and the humanist Renaissance), balance, harmony, proportion and resonance were everything. They capture the ancient Greek meaning of *kosmos* – the right placing of the multiple parts of the world ([Hillman 1981](#), 28). They are inherent in the music of the spheres, *i.e.*, astronomy, and in the design of cities and the human ecology in general:

The polis is the place of art... The magus, the poet who, like Orpheus and Arion is also a supreme sage, can make stones of music. One version of the myth has it that the walls of Thebes were built by songs, the poet's voice and harmonious learning summoning brute matter into stately civic forum. The implicit metaphors are far reaching: the “numbers” of music and of poetry are cognate with the proportionate use and division of matter and space; the poem and the built city are exemplars both of the outward, living shapes of reason. (Steiner, 1976)

4. In temples and public buildings, the ancient Greeks used the proportions of the human form for their columns. According to Marcus Vitruvius in the 1st century B.C.E., the Doric column represents the proportions of a man; the Ionian column, those of a mature woman; and, the Corinthian column, those of a young maiden (Vitruvius 1960, 103-104). Thus in ancient Greece and in the Renaissance ‘man was the measure of all things’. The human form provided the standard of measurement, *e.g.*, how many ‘hands’ high is a horse?

5. But beyond the human lay the universal forms of the circle, square, triangle and variations, *e.g.*, the parabola. Captured in Euclid’s *Elements*, two-dimensional space was reduced to the mathematics of such universal forms – their balance, harmony, proportion and resonance. Archimedes moved the cognitive relationship between number and nature into the three-dimensional world of volume. Measuring different forms of space was resolved by the Greeks through ‘exhaustion’ whereby one considers the area measured as expanding to account for successively more and more of the required space. In astronomy this method was extended to the celestial motion of the stars and planets. In effect, motion to the ancient Greeks was geometric exhaustion applied, step by step, through time. Ancient Greek mathematics was thus essentially concerned with spatial relationships finding its fullest expression in Euclidian and Archimedean geometry and the astronomy of Ptolemy.

6. After the fall of Rome, the works of the ancient Greek mathematicians were, for the most part, lost to the West. Only gradually were they recovered from Byzantine and Arab sources. In the interim, medieval guilds held a monopoly of tooled knowledge, or the ‘mysteries’ (Houghton 1941, 35) and operated without mathematical theory applying ‘rules of thumb’ and ‘magic numbers’. Even after recovery of Greek and Roman classics, guild masters and apprentices worked in the vernacular and did not have access to the ‘theoretical’ works, in Greek and Latin, of Archimedes, Euclid, Ptolemy or Vitruvius. The breakdown of the guilds and introduction of craft experimentation near the end of the medieval period, however, led to new forms and types of mathematics and instruments – scientific and musical - all calibrated to provide a mathematical reading of physical reality (Zilsel 1945).

7. In the early 15th century, the mathematical laws of perspective were discovered (or rediscovered) by the architect Filippo Brunelleschi (1377-1446). In accounting, innovation of the double entry ledger by Luca Pacioli (1445-1515) facilitated the commercial revolution first in the Mediterranean and then around the world. The need for improved navigation led to an intensive search for new methods and instruments to calculate longitude. The Royal Observatory was established in Greenwich in 1675 specifically for this purpose. It was not, however, until 1761 that John Harrison, “a working-class joiner” (BBC News Online, August 3, 2003), created his H4 ‘watch’ which proved sufficiently accurate and sturdy, under the stresses of 18th century sea travel, to permit reliable calculation of longitude. The spirit of playful fascination with new instruments and devices in the 17th and 18th centuries, especially those intended to measure longitude, is captured in Umberto Eco’s novel: *The Island of the Day Before* (Eco 1994).

8. Beyond the astronomical mathematics of Kepler and Galileo, it was canon fire that provided the impetus for development for a true mathematics of motion. In fact, the mathematics of cannon fire (and its patronage) provided the opportunity for many of the experiments of Galileo (Hill 1988) which are generally recognized as the beginning of the first Scientific Revolution. Mechanics began to drive mathematics.

9. In the 1670s, what was known as ‘the geometry of infinitesimals’, *i.e.*, geometric exhaustion, achieved a breakthrough with the simultaneous invention of ‘the calculus’, independently by Newton (1643-1727) and Leibniz (1646-1716). Calculus provided a true mathematics of motion – changing spatial position through Time expressed in algebraic rather than geometric terms. This breakthrough was then extended by Newton in his three laws of motion which arguably served as the foundation stone of modern natural science. By the middle of the 18th century, in France, ‘scientific’ engineering emerged with a requirement for formal training in calculus (Kranakis 1989, 18).

Standards

1. A quarter of a century before Adam Smith published *The Wealth of Nations* (Smith 1776), the French military changed its weapons purchasing policy imposing strict standards for the production of parts and final weapons systems, *e.g.*, artillery (Alder 1998). Standards were codified into mechanical drawings and mathematically defined tolerances subject to various physical forms of testing. Previously production was a craft activity with each part and weapon a unique artifact. This change meant that parts became interchangeable, *e.g.*, bayonets. This had

a significant impact on the performance of the French revolutionary armies of Napoleon ([Alder 1998](#), 536).

2. Standardized parts production was the first step towards ‘mass production’. It was followed early in the next century by the introduction, in England, of the first machine tools to guide and later to replace a worker’s hand to assure standards in production. The use of such machines led Charles Babbage to extend Smith’s theory of the division and specialization of labour to include payment only for the skill level actually required at each stage of production thereby encouraging a reduction of skill requirements, *i.e.*, craftspeople could be replaced by semi-skilled labourers (Rosenberg 1994, 32). This is the same ‘de-skilling’ that continues in the natural sciences with the introduction of new instruments, *e.g.*, the directly readable spectrometer (Baird 2004), and in industry generally.

3. It was not in Europe, however, that the system came to fruition. Arguably due to a shortage of skilled craftsmen and a predominantly low-end ‘mass’ market (rather than an upscale highly differentiated or ‘eccentric’ aristocratic one), it was in the United States that the system developed into ‘the American System’ (Hounshell 1983). Specifications and standards were designed into machines (machine tools) that were, in many cases, simply unknown elsewhere, *e.g.*, in England. Development of the British Enfield rifle in the late 1850s is a case in point. To the British who had carried on the old craft method of production, the idea of interchangeable parts for rifles was initially considered impossible until American machine tools and workers demonstrated how it could be done (Ames & Rosenberg 1968).

4. The American System, however, was not restricted to the military. It was extended to other industries in the United States including tableware such as knives and forks (Ames & Rosenberg 1968, 36). When standardized parts production was married to the moving assembly line introduced by Henry Ford in 1913, the modern system of mass production began. This combination became known as ‘Fordism’ or the “Fordist regime” ([David 1990](#), 356).

5. If standardized parts and the assembly line began mass production, it was innovation of “techno-economic regimes formed around general purpose engines” ([David 1990](#), 355) that completed the transformation of traditional into modern life-styles. The steam engine, railway, internal combustion engine, electric generator and computer require standardization not only of internal components but also external connectors ([Alder 1998](#), 537). As previously noted, general purpose tools, once innovated, establish a ‘path dependency’, *i.e.*, standards and specifications established at the onset become ‘locked in’ and all subsequent improvements, innovations or adjustments must comply. In a manner of speaking, the path dependency of

general purpose tools corresponds to ‘tradition’ for the medieval craftsman who inherited and was limited by ‘best practices’ established in a distant past.

6. The importance of standards is recognized in an emerging sub-discipline called *metrology* (O’Connell 1993). To anticipate discussion of technique, such networks produce what O’Connell calls ‘societies’ or what I call ‘technical subcultures’ including:

a society of health care facilities that share the same measure of body composition, a society of laboratories that share the same electrical units, and a society of weapons that share the same electrical and dimensional standards. (O’Connell 1993, 131)

7. In this regard, at the international level, engineering standardization began with the International Electrotechnical Commission (IEC) in 1906. The broader based International Federation of the National Standardizing Associations (ISA) was set up in 1926 and, after the Second World War, the International Standards Organization (ISO) was established in 1947. Today the ISO has forty distinct fields of standardization ranging from Environment to Image Processing to Domestic Equipment. In most fields mathematically defined standards are codified and then designed into hard-tooled knowledge to ensure compatibility anywhere in the world (Alder 1998, 537).

Technique

1. The French word ‘technique’ was introduced into English in 1817. Among its several meanings is: “a body of technical methods (as in a craft or in scientific research)” (MWO, *technique*, n, 2a). Quite simply such methods involve the effective use and application of hard-tooled knowledge - as sensor, tool or toy. Such use requires personal & tacit knowledge about a new instrument, its codification into operating manuals, and, then transfer of the instrument to a final user who, in turn, must decode the manual and then develop the necessary knowledge to become skillful in its use.

2. Hard-tooled knowledge acts like a nucleating agent around which technique develops like a routinized pattern of behaviour, or an institution in the tradition of the ‘old’ Institutional Economics (*e.g.*, Commons 1924, 1934, 1950). In this regard Price has called the instrument/technique relationship an ‘instrumentality’, *i.e.*, the nucleus *plus* orbiting behaviour (Price 1984, 15). For my purposes, the instrument is hard-tooled while the methods associated with its use constitute soft-tooled knowledge. They are, in economic terms, ‘tied goods’ like the punch cards required to run an old-style mainframe computer.

3. In genomics, Cambrosio & Keating have documented this nucleating role of instruments in “Art, Science, and Magic in the Day-to-Day Use of Hybridoma Technology”. They define scientific technique as an “embedded system of practices”. They highlight how much technique can only be learned by doing and/or through instruction, *i.e.*, it cannot be fully codified (Cambrosio & Keating 1988, 258).

4. Similarly, Rosenberg writes of “instrument-embodied technique” (Rosenberg 1994, 156). He observes that shared use of specialized instruments serves “to bring members of different disciplines together” countering the tendency towards incommensurability between scientific disciplines and sub-disciplines (Rosenberg 1994, 156).

5. Technique, of course, brings us full circle back to personal & tacit knowledge. Thus an instrument, any instrument such as the hammer becomes, for Heidegger, one with us in action, or, as “part of ourselves” (M. Polanyi 1962a, 59). Like a Zen master practicing archery for forty years, the arrow and the bow become transparent, only the target is seen (Suzuki 1959).

6.1.3.3 *Characteristics*

1. Tooled knowledge exhibits four characteristics: design, density, fixation and vintage. As introduction, design refers to the synthesis of knowledge drawn from different domains, disciplines, sub-disciplines and specialties, *e.g.*, biology, chemistry and physics, to create an instrument, *i.e.*, a sensor, tool or toy. Density refers to the operational opacity (or transparency) of the resulting instrument. Fixation refers to embedding knowledge into a functioning material matrix. Vintage refers to when that knowledge is embedded, fixed or frozen into a matrix. I will examine each in turn.

Design

1. As a verb, ‘design’ means “to create, fashion, execute, or construct according to plan; to have as a purpose” (MWO, *design*, v, 1). As a noun, it means deliberate purposive planning; the arrangement of elements or details in a product or work of art; the creative art of executing aesthetic or functional designs (MWO, *design*, n, 1a). Critically, engineers use the word design “in framing membership criteria for the professional grades of engineering societies” (Layton 1974, 37). More generally, however, in Design

we have come to recognize the processes which bring about creative advances in science, the new paradigms as processes of human design, comparable to artistic creation rather than logical induction or deduction which work so well within a valid paradigm... the norms of artistic design (are) “inherent in the specific psychic process, by which a work of art is

represented” and thus in the creative act, not in the created object - in the process not the structure . (Jantsch, 1975, 81)

2. From the dictionary definition I extract the terms ‘arrangement’ and ‘purpose’ in order to distinguish tooled from codified knowledge. Both codified and tooled knowledge are extra-somatic, *i.e.*, fixed outside a natural person. The purpose of codified knowledge, however, is transmission of knowledge between natural Persons while the purpose of tooled knowledge is measurement and manipulation of the natural world.

3. With respect to arrangement, codified knowledge involves manipulating an alphabet, grammar, syntax and vocabulary, *i.e.*, a language including mathematics, to communicate with other human beings. Arrangement of tooled knowledge, however, involves the coordination of different forms and types of matter and energy to subsequently and artificially manipulate or animate the natural world. This may include synthesizing bits of biological, chemical, cultural, economic, electric, electronic, ergonomic, mechanical knowledge and/or organizational knowledge into a single working device or instrument. Put another way:

The term “design” covers the mutual employment of the material and the propositional, as well as hybrid forms such as drawings, computer simulations, and material models. However, design must be understood to embrace material knowledge as well as ideational knowledge. The “design paradigm” is the most promising recent development in the epistemology of technology, but it must not lose track of this central insight about design. Thought and design are not restricted to processes conducted in language. (Baird 2004, 149)

4. As an example, consider the common electric hand drill. Functionally it makes a hole. Without a drill one can use a simpler tool like a spike. This requires knowledge of materials technology, *e.g.*, balsam won’t work well. One either pounds away or rotates the spike with little control or effect unless one spends a very long time developing the tacit knowledge of how to do so. If instead one mounts the bit and turns a crank handle to drive a hardened specially shaped shaft (embodied knowledge of mechanics as well as materials technology) then the operator can achieve much more control and effect. One has invented the hand drill. If one powers the crank by electricity (knowledge of electric motors), then at the push of a button one hand can achieve more control and effect. If one then computerizes the button, one frees the hands, body and mind of the operator. One has invented a computerized machine tool that embodies knowledge streams of materials technology, mechanics, electricity and computers - all in one.

5. Layton, quoting Herbert Simon, defines the “sciences of the artificial” as involving synthesis or what I call ‘design’ rather than analysis or ‘reduction’. Furthermore: “the engineer

is concerned with how things ought to be - ought to be, that is, in order to attain goals, and to function” (Layton 1988, 90-91).

6. Michael Polanyi also recognized the artificial nature of tooled knowledge. He observed a machine can be smashed but the laws of physics continue to operate in the parts. He concluded that: “physics and chemistry cannot reveal the practical principles of design or co-ordination which are the structure of the machine” (M. Polanyi 1970).

7. Put another way, in another context, by another author: “technology is about *controlling* nature through the production of *artifacts*, and science is about *understanding* nature through the production of *knowledge*” (Faulkner 1994, 431). In Aristotle’s *Nicomachean Ethics* “art is identical with a state of capacity to make, involving the true course of reasoning” (McKeon 1947, 427). The connection between the Arts and tooled knowledge is captured in the aesthetic term *elegant*, i.e., “ingenious simplicity and effectiveness” (OED, *elegant*, a, 5a). Put another way: “design involves a structure or pattern, a particular combination of details or component parts, and it is precisely the gestalt or pattern that is of the essence for the designer” (Layton 1974, 37).

8. This gestalt is generally expressed in visual rather than verbal terms. In fact, the earliest expression of engineering knowledge in the West takes the form of design portfolios and the “natural units of study of engineering design resemble the iconographic themes of the art historian” (Layton 1976, 698). In the experimental sciences, this is also increasingly true. Quoting Ackerman, Idhe observes:

Visual thinking and visual metaphors have undoubtedly influenced scientific theorizing and even the notation of scientific fact, a point likely to be lost on philosophers who regard the products of science as a body of statements, even of things. Could the modern scientific world be at its current peak of development without visual presentations and reproductions of photographs, x-rays, chromatographs, and so forth? ... The answer seems clearly in the negative.” (Idhe 1991, 93)

9. There is, however, a Western cultural bias towards ‘the Word’ and away from ‘the image’ – graven or otherwise (Chartrand 1992a). This has contributed to the epistemological suppression of tooled knowledge relative to ‘scientific’ knowledge which is usually presented in a documentary format (the article or book) while tooled knowledge appears first as an artifact which must then be transliterated into written formats that “savour of the antiquarian” (Price 1965, 565-566).

10. Another connexion between tooled knowledge and the Arts is found in the expression “from art to science” (Cambrosio & Keating 1988, 256). This transition has been documented in

biotechnology (Hood 2002) and engineering (Schön, 1983) with respect to experimental techniques or protocols. Such protocols generally begin as the unique tacit knowledge of a single researcher. This is called ‘magic’ by Cambrosio & Keating. Over time, this tacit knowledge becomes embodied in an experimental piece of hardware, *i.e.*, tooled knowledge. This stage they call ‘art’ because operation of the prototype requires a high level of tacit knowledge or skill. In turn, the prototype may be commercially transformed into a standardized instrument requiring less skill of its operator who, in effect, transforms from a scientist into technician (Rosenberg 1994, 257-258). This, according to Cambrosio & Keating, is the ‘science’ stage when the standardized instrument can be routinely used in the ongoing search for new knowledge. The original protocol, however, becomes effectively embodied in the now standardized, calibrated scientific instrument. Put another way:

In the language of technology studies, these instruments “de-skill” the job of making these measurements. They do this by encapsulating in the instrument the skills previously employed by the analyst or their functional equivalents.”
(Baird 2004, 69)

11. In summary, design refers to the synthesis of different forms of knowledge – cultural, economic, organizational as well as scientific. Tooled knowledge is thus synthetic and integrative rather than analytic and reductive. Through design it enfolds or integrates many different forms of knowledge, including economic knowledge, into an efficient instrument (technically and economically) that works and performs its function. In this sense, tooled knowledge achieves the ancient Greeks *kosmos*: “the right placing of the multiple parts of the world” (Hillman 1981, 28). The world is in harmony; the world works. In more prosaic terms: “Development of the design is coordinated and iterative, and the end product succeeds in *integrating* all of the necessary knowledge” (Faulkner 1994, 432).

Density

1. Among its several meanings, the word density means “the degree of opacity of a translucent medium” (MWO, *density*, n, 3a). With respect to tooled knowledge, density refers to the operational opacity (or transparency) of an instrument. The more tooled knowledge is embodied in an artifact, relative to its function, the denser, the more opaque, the instrument becomes, *i.e.*, it requires less and less personal & tacit or codified knowledge to operate. In other words, the denser an instrument becomes, the more ‘user friendly’.

2. At one extreme are ‘one-offs’, customized instruments common in the natural sciences. A particle accelerator or synchrotron is unique. No two are alike; the personal & tacit and codified knowledge required to maintain and operate it is large. It requires a great deal of what

is called ‘local knowledge’ (Alder 1998, 537; Faulkner 1994, 445). In this sense the covers are kept off the machine. It is transparent requiring constant looking inside and tinkering to make it function correctly. Its operation involves the “craft of experimental science” (Price 1984). This sense is captured by an aphorism told by Professor Tom Steele of the Department of Physics & Engineering Physics about the Canadian Light Source synchrotron at the University of Saskatchewan. A problem with vacuum containment baffled staff until a visiting vacuum specialist offered to check it out. He walked around the circuit twice and then pointed out where the problems lay. At first staff laughed but then instrumentation confirmed the expert’s findings. He required no instruments, no measurements, *just* experience, *i.e.*, personal & tacit knowledge.

3. At the other extreme is the consumer ‘black box’ – push the button and it operates itself. The leading edge of black box tooled knowledge, today, is voice activated computer control. Just a verbal command and the tooled knowledge works. The black box hides its ‘thing-ness’ (Baird 2004, 146).

4. Between the extremes are many shades of grey. Standardized research instruments like scanning electron microscopes or MRI scanners require highly trained technicians to operate. They can do so, however, without the detailed personal & tacit and codified knowledge available to an experimental scientists. This again involves a ‘de-skilling’ of the operator and transfer of knowledge into the instrument (Baird 2004, 69).

5. The process of standardizing experimental scientific instruments by replacing manual with automatic control is well documented (Cambrosio & Keating 1988; Hood 2002; Price 1984; Rosenberg 1994). It involves conversion of a transparent scientific sensor into an opaque industrial tool that, in turn, may become a black box toy in final consumption, *e.g.*, the cathode display tube as TV.

6. The impact of soft-tooled knowledge in this process, especially standardization, cannot be underestimated:

For all the diversity of our consumer cornucopia, the banal artifacts of the world economy can be said to be more and more impersonal, in the sense that they are increasingly defined with reference to publicly agreed-upon standards and explicit knowledge which resides at the highest level of organizations, rather than upon local and tacit knowledge that is the personal property of skilled individuals. (Alder 1998, 537)

Fixation

1. Tooled knowledge is fixed in a functioning material matrix as a sensor, tool or toy. Fixation is a condition for intellectual property rights such as patents and copyrights. I will

discuss the nature of such intellectual property rights in more detail below. For now it is sufficient to ask if tooled knowledge can be extracted from such a matrix? The answer is yes through reverse engineering. In effect, “engineers learn the state of the art not just by reading printed publications, going to technical conferences, and working on projects for their firms, but also by reverse engineering others’ products” (Samuelson & Scotchmer 2002, 70-71).

Vintage

1. Vintage refers to the temporal coefficient (historical date or time) when existing knowledge is embedded, embodied or tooled into a matrix. Unlike design, density and fixation, vintage has been the subject of formal economic investigation. Robert Solow (1960) considered the question of the distribution of capital equipment including new and old technologies and asked why different vintages coexist. Subsequently, Solow introduced the concept of ‘embodied technological change’ (1962).

2. Like codified knowledge when the hand has written it moves on, tooled knowledge exists at a given moment of time – a given state of the art. Once embedded, it is ‘frozen’ (Boulding 1966, 6) and subject to update with more effort and cost than revising a written document. Vintage thus refers to the state of the art current when knowledge is tooled into matter. Furthermore, and excepting the military and natural sciences, it is also subject to economic constraints (M. Polanyi 1960-61, 404).

3. One further vintage distinction can be drawn: technical versus functional obsolescence. On the one hand, a given product or process embodying tooled knowledge may be displaced by one that is faster and/or more cost-effective. The old is now technically obsolete. It can continue, however, to perform the same or similar function. On the other hand, a given product or process may be displaced because the function it performs is no longer required. The old is now functionally obsolete. An example is hydrogen re-fuelling stations for zeppelins.

6.1.4 Reconciliation

1. Knowledge takes three forms – personal & tacit, codified and tooled. Knowledge is fixed in a person as neuronal bundles of memories and as the trained reflexes of nerves and muscles. As code it is fixed in a medium of communication or matrix that allows knowledge to cross Time and Space until another person reads or decodes it and thereby adds it to his or her personal & tacit knowledge. Knowledge is tooled into a functioning physical matrix as an instrument such as a sensor, tool or toy, or more generally, as a work of technological

intelligence. The knowledge tooled into an extra-somatic matrix remains a functionless artifact, however, until someone makes it work by pushing the right buttons and using it in the right way. This requires, of course, personal & tacit knowledge that comes with practice, talent and technique. Thus, once again, we can conclude that all knowledge is ultimately personal and tacit.

6.2 As Input

1. Economics concerns the satisfaction of human wants, needs and desires with limited means. In the Standard Model, satisfaction is achieved by consumers extracting utility (consumption) from goods & services purchased (demand) from firms that produce them (production) as outputs (supply). Firms combine factors of production or inputs injecting utility into outputs. The knowledge of how to combine inputs and inject utility into outputs is called ‘technology’.
2. In terms of Heidegger’s technology, outputs are the formal cause taking a specific form to satisfy a specific consumer need, *e.g.*, Heidegger’s sacrificial silver chalice ([Heidegger 1955](#), 6). The material cause is the raw material or inputs used, *e.g.*, the silver used for a chalice rather than for knives and forks. The efficient cause is the firm or entrepreneur, *e.g.*, Heidegger’s silversmith. The final cause is profit earned by satisfying human wants, needs and desires. In this section I consider material cause, specifically how knowledge enters the economic process as input.
3. In the Standard Model, traditional inputs include: capital that earns interest; labour that earns salaries & wages; and, natural resources that earn rent. Sometimes entrepreneurship is also included in the list. It earns profits, *i.e.*, what is left of revenue once all other factors of production have been appropriately rewarded. The position of entrepreneurship in the Standard Model is, however, problematic. It is usually subsumed under capital assuming it flows from the risk-taking owner of capital who runs the firm, *i.e.*, the owner is in the store. Alternatively, however, entrepreneurship may be subsumed under labour assuming separation of ownership (shareholders) from control of the firm (the entrepreneurial CEO). Thus arises the question of ‘agency’, *i.e.*, does the CEO pursue the interests of the owners or his own? As will be seen below, the choice is both functional and ideological. I will now demonstrate that traditional economic inputs - capital, labour and natural resources – can be expressed in terms: codified & tooled capital, personal & tacit labour and toolable natural resources.

6.2.1 Codified & Tooled Capital

1. The definition of capital is an unresolved problem in economics. To Marxists, it is theft. To the mainstream, its definition remains problematic as noted by T.K. Rymes of Carleton University in conversation with the author in the early 1970s: “If there is no theory of capital, there is no economics. And there is no theory of capital!”

2. The concept of capital has mutated and expanded through history. To the Mercantilists of the 17th century, capital was gold, silver, land and slaves. To the Physiocrats of pre-Revolutionary France, it was the surplus generated by agriculture. To the Classical School of the late 18th and early 19th centuries, it was the surplus resulting from the division and specialization of labour. To the Neo-Classical School of the late 19th and 20th centuries, it was financial capital as well as physical plant and equipment. To Bohm-Baverk and the Austrian School, capital was historically embodied labour produced through ‘round-about’ means of production (Blaug 1968, 510-11). How to measure such embodied labour has never, however, been satisfactorily answered (Dooley 2002). Today, when economists speak of capital, they may refer to cultural, financial, human, legal, physical, social or other forms expressed as a stock, *e.g.*, physical plant and equipment existing at a given moment in time.

3. For my purposes, capital is codified and tooled knowledge, *i.e.*, knowledge fixed in an extra-somatic matrix. Alternatively, capital is “knowledge imposed on the material world” (Boulding 1966, 5), or, “frozen knowledge” (Boulding 1966, 6). It includes:

- codified knowledge in the form of human-readable information management systems and databases, operating manuals and libraries as well as associated intellectual property rights such as copyrights, patents, registered industrial designs and trademarks; and,
- ‘hard-tooled’ knowledge in the form of physical plant and equipment, *i.e.*, sensors and tools, plus related ‘soft-tooled’ knowledge including machine-readable computer & genomic programs, standards and techniques.

4. Codified and tooled knowledge are fixed in material form; both have vintage; both are extra-somatic, *i.e.*, they exist outside the natural person. I will now briefly examine softer forms of capital - cultural, financial, human, legal and social - expressed as codified and tooled knowledge. Physical plant and equipment, *i.e.*, physical capital, has been demonstrated to be tooled knowledge by which we enframe and enable the production process.

6.2.1.1 *Cultural*

1. Cultural capital, as artworks, books, photographs, plays, recordings, *etc.*, is codified knowledge. As broadcast & recording studios, conservatories, libraries, museums, parks, printing presses, sets, props & costumes, theatres and other venues, it is tooled knowledge. In this sense, cultural capital (codified and tooled) contrasts with cultural practice or performance which is personal & tacit in nature.

6.2.1.2 *Financial*

1. Financial capital as currency, equities, bonds, mortgages and other financial instruments is codified knowledge, *i.e.*, fixed on paper or in human readable electronic format. Anti-counterfeiting measures such as encryption, electronic strips and chips are forms of tooled knowledge. Debit and ‘smart’ cards are contemporary examples of financial capital as tooled knowledge. In this view, financial capital (codified and tooled) contrasts with financial practice which, again, is personal & tacit in nature.

2. It is as personal & tacit knowledge, however, that financial capital plays its primary role. As a generally accepted medium of exchange, store of value or unit of account, financial capital as money involves tacit knowledge routinely recognized and accepted by a natural person. In this sense, financial capital, including the price system ([Hayek 1989](#)), is an institution, *i.e.*, a routinized pattern of collective human behaviour. Like a physical reflex, *e.g.*, riding a bicycle, a human being learns to recognize, accept and exchange financial capital. In different cultures and periods of history what constitutes money and financial capital differs ([K. Polany 1944](#); [Humphreys 1969](#)). In other words, financial capital is a cultural artifact, a form of organizational technology that is tacit, *i.e.*, ‘generally accepted’ in a society.

6.2.1.3 *Human*

1. Human capital generally refers to the stock of skills and education possessed by a worker. Given human capital is embodied in a living human being, there is no extra-somatic component, *i.e.*, there is no capital as frozen knowledge. The term ‘human capital’ is thus a misnomer. Human capital is personal & tacit knowledge and somatic to the individual. Additions to this stock reflect learning, education, experience and training on the memory and reflexes of the individual.

6.2.1.4 *Legal*

1. Legal capital as law books, statutes, judicial and quasi-judicial decisions is codified knowledge. Legal capital as court houses, handcuffs, prisons and police cars is tooled knowledge. In this view, legal capital (codified and tooled) contrasts with legal practice which is personal & tacit knowledge.

6.2.1.5 *Social*

1. Social capital can be codified and fixed on paper or another human-readable format stating customs and conventions of behaviour, educational curricula, public rules and regulations as well as public safety standards, *e.g.*, drinking water standards. Social capital as schools, hospitals, roads, sewage & water systems and telecommunication systems is tooled knowledge. In this view, social capital (codified and tooled) contrasts with social practice including market sentiment which are personal & tacit.

2. Social capital, according to some scholars, can be extended to include “values and beliefs” (Maskell 2001, 2). Such values and beliefs can be codified, *e.g.*, the Analects, Bible, Koran & Vedas. Alternatively, they can be tooled into monuments and other works of aesthetic intelligence reflecting an ideology, *e.g.*, socialist realism. Values and beliefs, however, take on meaning only when practiced or perceived by a living human being. In this sense, there is no extra-somatic component, *i.e.*, there is no capital or asset that can be exchanged for money. Put another way, “Money can’t buy you love”.

3. With respect to economics, such values and beliefs include market sentiments. In *The Theory of Moral Sentiments* and *The Wealth of Nations*, Adam Smith stresses the role of Sentiment in market exchange, *e.g.*, trust (*The Economist* Feb. 20, 2003). As Samuels put it, “the order produced by markets can only arise if the legal and moral framework is operating well” (Samuels 1977, 197). Together with division and specialization of labour, it is market sentiments, according to Smith, that assures the wealth of nations. In effect, Sentiment influences Reason and Reason influences Sentiment including economic expectations. Put another way: no matter the price, would you buy a used car from that person?

4 To the degree that various forms of capital – cultural, financial, legal, physical and social – can be expressed as codified and tooled knowledge, one may speak of ‘a knowledge theory of capital’. As will be demonstrated, however, such a theory is a corollary to a more general ‘labour theory of knowledge’.

6.2.2 Personal & Tacit Labour

1. If the definition of capital is unresolved, the economic definition of labour is problematic in the extreme. In conventional terms, labour refers to the physical and mental effort of a worker in the production of goods & services. Labour, unlike capital, has been subject to definitional reduction, not expansion. It has been subject to capitalization rather than humanization as a factor of production. Thus education and training add to the stock of 'human capital', something ideologically alienated from labour and subject to managerial control as a corporate or national asset. Similarly, entrepreneurship and management have become detached from labour even though separation of ownership from control – public or private - makes the manager an employee or agent, not a principal or owner. In effect, labour becomes warm hot bodies applying muscle not brains doing what it is told. Effort is organized according to a division and specialization of labour (brawn) determined by a specialized class of employee called management (brains).

2. But why should one class of labour 'work' and another 'manage'? This was the subject of Richard Bendix's historically exhaustive *Work and Authority in Industry: Ideologies of Management in the Course of Industrialization* (1956; 1976; 2001). Bendix traces the conceptual history of modern management back to feudal times. He finds, in effect, a theory of positive thinking: managers have a positive self-image and can defer gratification while workers do not and cannot. Bendix thereby captures perhaps the last embers of the 'Iron Law of Wages'. Classical economics accepted, with relative equanimity, the starvation of labour who must then accept lower real wages or who, alternatively, with higher real wages simply bred increasing the labour supply and thereby lowering wages through competition. Full employment, under the Classical model, was assured on the backs of labour, or what Marx called "the surplus army of the unemployed".

3. John Kenneth Galbraith in his *New Industrial State* (1967) went further and described the modern corporation as governed by a self-replicating technostructure of managers produced by and selectively chosen from graduates of so-called 'B' or business schools. It is they who direct workers on behalf of an ever increasing and diffuse pool of shareholder-owners. Galbraith also explored the relationship between large corporations and a newly emerging class of labour - creative talent, specifically artists (*Economics & The Public Purpose*, 1973). While the classless genius emerged with the Renaissance's artist/engineer/humanist/scientist, by definition, it is exceptional and has not, historically, constituted a distinct class of labour. As will be seen, however, in the hands of Reich (1990) and Drucker (1998), a new class of creative workers has

emerged called, respectively, 'symbolic' or 'knowledge' workers. In fact, there are three distinct classes of knowledge workers: productive, managerial and entrepreneurial.

6.2.2.1 *Productive*

1. Productive workers are those on the shop floor actually producing goods & services. They are concerned with output. Their knowledge is technical and specialized to a given industry or firm. In effect they combine codified and tooled with personal & tacit knowledge (memory and reflex) generally learned on the job in the Anglosphere. Their knowledge involves making something or making something work. In this sense the competitiveness of a firm or nation "depends not only on sensible decisions about what to do, but on the availability of the skills that are required to do it" (Loasby 1998, 143).

6.2.2.2 *Managerial*

1. Management, among other things, means "a governing body of an organization or business, regarded collectively; the group of employees which administers and controls a business or industry, as opposed to the labour force". It also means "the group of people who run a theatre, concert hall, club, etc" (OED, *management*, n, 6). The role of management is to make available the means (inputs) so that production workers can perform their tasks and then to market and distribute the output. In many ways management is like a choreographer, music or theatre director. This sense of modern management is caught by Aldrich:

Thus the total operation is a performing art with blueprints for score or choreography, the difference being that in this technological case neither the co-ordinated performances (ballet) of the skilled workers nor the finished product is put on exhibit simply to be looked at, contemplated. It is a useful performing art. Its value is instrumental." (Aldrich 1969, 381-382)

2. Similarly, according to Schlicht, it is:

the fit of the organizational elements, rather than the elements themselves, that characterizes a firm. Just as the quality of an orchestra performance cannot be adequately measured by the average quality of the performances achieved by the individual instruments, but depends crucially on the way the instruments are played together, so the productive value of a firm - as opposed to a set of individual contracting relationships - emerges from the quality that has been achieved through mutually adjusting the various activities that are carried on. (Schlicht 1998, 208)

3. One crucial characteristic of the firm is custom including tacit understandings of entitlements and obligations between productive, managerial and entrepreneurial workers. This constitutes part of what is commonly called 'the corporate culture' for which, on a day-to-day

basis, management is responsible. Such entitlements and obligations are based on Sentiment, *i.e.*, a sense of right and wrong, of fair and unfair, rather than the rule of Reason. Management of a firm involves maintaining an “an island of custom in the ocean of the market” (Schilcht 1998, 207). Sentiment has found expression in the work of Howard Gardner and his concept of ‘emotional intelligence’. This and other forms of multiple intelligence, have been formally introduced into management literature with his new Harvard Business School book: *Changing Minds: The Art and Science of Changing Our Own and Other People's Minds* (Gardner 2004).

6.2.2.3 Entrepreneurial

1. With the notable exception of firms like Microsoft (Bill Gates) and Walmart (Sam Walton), most modern corporations do not follow an original founder/owner but rather a ‘hired gun’, or business entrepreneur. The word ‘entrepreneur’ comes from the French *entre* meaning ‘between’ and *prendre* meaning ‘to take’. The English ‘middleman’ retains this original sense. During the Middle Ages and Renaissance, European traders (especially from Venice and Genoa) ‘middled’, at high risk, between foreign suppliers, *e.g.* of silk and spices from the Turks, and final consumers in northern Europe. Today the term usually refers to someone who sees and seizes an economic opportunity or a market opening or gap. This may take the form of a new product or of servicing an existing market in a new way. In both cases a high degree of creativity and risk-taking is implicit. In this regard, the first English usage of ‘entrepreneur’ was in 1828 meaning “the director or manager of a public musical institution.” Today we would call this ‘an impresario’. In fact, it was not until 1852 that entrepreneur took its modern meaning of “one who undertakes an enterprise; one who owns and manages a business; a person who takes the risk of profit or loss (OED, *entrepreneur*, a, b).

2. Entrepreneurial knowledge is intuitive in seeing and taking advantage of invariants and affordances in a market that others do not see. It involves seeing and realizing a vision of future markets, products and opportunities. Ignorance is the opposite of knowledge, *i.e.*, want of knowledge. The non-rational way of entrepreneurial vision was called ‘animal spirits’ by Keynes (Keynes 1936, 161). Like some ancient priest-king, the entrepreneur ‘knows’ the future and leads his people (investors, managers, workers and consumers) into it – right or wrong - to success or failure. In a manner of speaking, prophets today seek profits, not souls. Ideally, this highly valued form of pattern recognition works best as “informed intuition” (Jantsch 1975). All available information, knowledge and opinion is explicated but then an intuitive, inductive judgemental vision is conjured up. In a sense, the business entrepreneur or CEO has assumed the mantle of the Western Cult of the Genius joining the artist, inventor and scientist.

6.2.3 Toolable Natural Resources

1. At first glance, natural resources appear to have no relationship to knowledge. By definition, they exist as John Locke said in “the State that Nature hath provided” (quoted in [Dooley 2002](#), 4). They are just part of the environment until the knowing mind recognizes them as useful. Thus oil lay in the ground virtually untapped until invention of the internal combustion engine. Just as we recognize a tool by its purpose (M. Polanyi 1962a, 56), we similarly identify natural resources by the human ends we attribute to them. At a given point in time a naturally occurring substance is seen as nothing but an environmental feature. Take a pathway through the jungle one day and you see a large rock outcrop. The next day, with new knowledge, the same path leads not to an environmental feature but to a bauxite deposit that can be converted into aluminum. It has become a toolable natural resource. Yet it itself has not changed, one day to the next, rather new knowledge allows us to see it in a different light.

2. This ‘changed way of seeing’ is captured by Loasby when he writes:

Menger begins by arguing that an object becomes a good only when someone discovers how to use it to satisfy some human need. Goods are endogenous, created by new connections between human need and physical or human resources; and their value is derived from the need which each of them serves and - crucially for this paper - from the knowledge that it can serve this need and also the knowledge of how it can be made to do so... The creation of goods, and of technology, rests on the creation of knowledge, and therefore on previous uncertainty - or indeed sheer ignorance.” ([Loasby 2002](#), 6)

3. Before turning to outputs, I must ask why capital has been subject to such extensive conceptual division and specialization while the concept of labour has narrowed. The explanation, in my opinion, lies in the great schism between Marxist and Market Economics. Marxists attributed all productive value to labour. In response, Marketers focused on capital minimizing the role of labour. In effect, the Standard Model capitalizes rather than humanizes labour. With emergence of the knowledge-based economy, however, this is changing. Quite simply, if all knowledge is ultimately personal & tacit then one may meaningfully speak of a knowledge theory of capital as corollary to a labour theory of knowledge.

6.3 As Output

1. Outputs of a knowledge-based economy, as formal cause, can also be expressed in terms of personal & tacit, codified and tooled knowledge. If we assume all human wants, needs and desires can be transliterated into ‘needs to know’ then some goods and services satisfy physical needs such as the need to know heat on a cold winter day. Some satisfy abstract needs like the need to know God. Quite simply, knowledge satisfies ignorance, *i.e.*, want of knowledge (OED,

ignorance, 1 a). Ignorance is, however, indeterminate. We simply don't know what we don't know until we do. Furthermore, in economics there is no aesthetic distancing, no moral judgement, no scientific objectivity in satisfying a want of knowledge. Every good and service that yields the pleasure of knowing from food to sex from religion to science are legitimate epistemic object (Rheinberger 1997), *i.e.*, whatever a human being wants to know is the legitimate subject of economic investigation. It is in this sense that economics is an *amoral* discipline. For my purposes, there are three knowledge outputs – the Person, the Code and the Tool.

6.3.1 The Person

1. The Person comes in two forms: as an intermediate and as a final good. As an intermediate output the Person is utilitarian, *i.e.*, valued for a purpose other than oneself. As a final output, the Person is non-utilitarian, *i.e.*, valued in-and-of-oneself. Arguably, the Person is the ultimate output of a knowledge-based economy. This perspective reflects, among other things, democratic republicanism and its principle of one person one vote as well as the U.N.'s Declaration of Universal Human Rights.

2. As an intermediate output, it is through education, training and experience that personal & tacit knowledge is somatically fixed into neuronal bundles of memories and conditioned reflexes. Examples include the tailor, tinker, soldier and spy as well as astronomer, athlete, sub-atomic particle physicist and genomicist and, lest we forget, the accountant, economist, engineer, lawyer, physician, *et al.* In this sense, all Persons are knowledge workers whether they rely upon the processing of memories fixed in neuronal bundles or the trained reflexes of nerve and muscle engaged in handling physical products. In this view, a manual labourer is a knowledge worker. Lack of knowledge, *e.g.*, of how to lift heavy objects, has economic consequences such as workman's compensation. This excludes, of course, artificial or 'legal persons' called 'bodies corporate'.

3. The Person, as final knowledge output, in a biological sense, fulfills the teleological need to know. Consider the 2004 Summer Olympics in Athens. The best athletes in the world demonstrated what trained human reflexes and knowledge from practice and experience can achieve together with sports medicine. The scholar similarly exercises and trains his brain like any volitional organ and builds up neuronal connexions of argument, evidence and reasoning of one's own making as well as coded knowledge of other scholars distant in time and space. Making such connexions is a naturally pleasurable activity in its own right. It satisfies ignorance

by fulfilling the biological need to know. The power of this human need is evident to every parent by the phrase: ‘Why mommy?’

4. Beneath the surface of conscious and volitional knowledge, however, lay the twinned domains of the personal and collective unconscious. Socrates is famous for, among other things, recognizing that one knows but knows not that one knows. Such knowledge forms part of the personal unconsciousness and the Socratic method is a traditional way of raising it to consciousness. Another is the ‘talk therapy’ of analytic psychology. As to the collective unconscious, it “contains the whole spiritual heritage of mankind's evolution, born anew in the brain structure of every individual” (Jung, *The Structure of the Psyche*, CW 8, par. 342 quoted in [Sharp 1991](#)). Analytically, access to such collectively unconscious knowledge is through active imagination, fairy tale, myth and legend generally *via* art and religion.

5. For a metaphysical perspective, however, I must change terms. The word ‘Person’, according to the OED, is sometimes used “as a substitute for Man” (OED, *person*, n). The word ‘person’ itself comes from the Old French *persone* out of the Italian meaning “a mask used by a player” (OED, *person*, n, I 1). The word ‘man’, as in ‘human’, however, is rooted in the classical Latin *humus* and the ancient Greek chthonic meaning ‘earth’” (OED, *man*, n. 1, Etymology). Thus the word ‘Man’ derives from humus or earth and our species, *homo sapiens*, is literally ‘the wise earth’ or ‘earth wise’.

6. Beyond sapience, however, two other characteristics distinguish our species: ‘humour’ and ‘humility’, words sharing the same root as *homo*. Quoting the holy woman Therese of Lisieux: “Humility isn't at all about denying one's abilities and accomplishments. Humility is simply knowing the truth about yourself, and about where you come from, and about Who gets the ultimate credit” (Ruof, December 5, 1996). This catches the sense of *homo sapiens sapiens*, *i.e.*, the man that knows he knows. As to humour, Ruof notes that “to be human is to know humor. And to have humor is to have the ability to see through things. It's the knack, as it were, of seeing two different or conflicting things at once, which when brought together are simply funny. The classic example ... is the elegant-looking gentleman in top hat and tails slipping on a patch of ice and falling on his tail” (Ruof, December 5, 1996).

7. The creation myth of the world's three great monotheistic religions (or theistic ideologies) – Judaism, Christianity and Islam – share, among other things, the belief that humanity was created from the earth, or more precisely God created ‘them’- male and female. These ‘people of the Book’ share the First Book of Moses called *Genesis* in which it is written:

Genesis 1.26 And God said, Let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the

fowl of the air, and over the cattle, and over every creeping thing that creepeth upon the earth.

Genesis 1.27 So God created man in his *own* image, in the image of God created he him; male and female created he them.

8. While this text has been subjected to more exegesis and analysis than any document in human history, I am compelled to offer yet another. First, why did God create ‘them’? Thomas Mann answers that:

“The Angels,” so ran the train of thought, “are created after Our image, but yet not fruitful. The beasts, on the other hand, lo, they are fruitful, but not after Our likeness. Let Us create man - an image of the angels, yet fruitful withal!” (Mann 1944, 4)

9. Second, dominion over the world was granted to ‘them’, male and female. It is only later in *Genesis* (2.22) that a splitting off of the original or first Adam (male and female) produces a submissive and passive Eve. Accordingly, use of the word ‘Person’ is intended to escape sexist implications. It also highlights the ‘speciation’ of feminist studies which now occupies a seat at the university’s table of thought. For most of human history, however, sexual apartheid has been the norm. In the most simplistic terms, men were encouraged to develop Reason in its reductive and destructive sense, *i.e.*, the warrior, while women were encouraged to develop Sentiment in its relational sense. In the secular West (as opposed to the religious West) sexual apartheid and its epistemological corollaries have, more or less, been rejected. This rejection, however, has, in turn, alienated much of Islam (as well as ‘fundamentalist’ Hinduism, Judaism and Christianity) fuelling the so-called ‘war on terror’ that has come to dominate life at the beginning of the 21st century. In other words, Al Qaeda’s ideological effort to establish a global caliphate is rooted in opposition to the equality of women and of ‘women’s knowledge’.

10. Before the appearance of Eve, however, God created, for the original androgynous Adam, a Garden of Eden in which there was “the tree of life ... and the tree of knowledge” (*Genesis* 2.9). God permitted Adam to eat of all the trees in the garden but warned: “But of the tree of the knowledge of good and evil, thou shalt not eat of it: for in the day that thou eatest thereof thou shalt surely die” (*Genesis* 2.17). The serpent, the story goes, convinced Eve that instead “in the day ye eat thereof, then your eyes shall be opened, and ye shall be as gods, knowing good and evil” (*Genesis* 3.6). And when Eve, in turn, convinced Adam to eat of the fruit, “the Lord God said, Behold, the man is become one of us, to know good and evil: and now, lest he put forth his hand, and take also of the tree of life, and eat, and live forever” (*Genesis* 3.22) expelled the duo from the garden and “placed at the east of the garden of Eden Cher’-u-bims, and a flaming sword which turned everyway, to keep the way of the tree of life” (*Genesis* 3.24).

11. Significantly there was no injunction against eating of the tree of life before the Fall from what traditionally is called ‘innocence’ but which, in this context, is ignorance. The price paid for the fruit was not just knowing good and evil but also knowing death. And it is knowledge of death that ultimately distinguishes a Person from extra-somatic forms of knowledge such as Code or Tool which can never ‘know’ death. Heidegger (Greene 1957) makes much of death, the realization of which shocks one into seeing Time not as history or abstraction but as one’s being defined by a very personal beginning and end.

12. Dominion over Nature was not, however, withdrawn after the Fall and its key was arguably found by Francis Bacon in the instrumental experimental scientific method. Arguably, this leads us back to the tree of life in the guise of the DNA helix promising, if not life everlasting, a significant increase to the three score and ten years granted to the fallen Adam. This explains, in part, resistance in the religious West to human stem cell research and its embrace by others. Arguably, however, the flaming sword of God still bars the way to the tree of life, at least in some countries and cultures. Alternatively, we can follow the advice of the German playwright Kleist:

Consequently, I said a bit distracted, we would have to eat again from the tree of knowledge in order to return to the state of innocence. Indeed, he answered, this will be the last chapter in the history of the world. (quoted in Jantsch 1975, 263)

13. The ‘sensational’ or ‘earthy’ nature of human knowledge cannot be ignored. Consider the classic miser counting his gold as having carnal knowledge with his money (OED, *knowledge*, n, II, 7). By ignoring the mortality of neuronal bundles and reflexes, we metaphysically slip, abstracting ourselves beyond the realm of human knowledge into that of artificial intelligence. Thus Hubert L. Dreyfus, one of the leading critiques of artificial intelligence,

asserts that in order to think, one must have (be) a body. The rationale for this assertion comes from existential phenomenology, particularly that of Merleau-Ponty. Since computers do not have (human) bodies, they thus cannot think (humanly). It is this identification of body as a necessary condition of thought which is of primary interest here. (Idhe 1991, 69)

14. One last Biblical reference needs to be raised due to its ideological implications. Judaism, Christianity and Islam share the paradigm of ‘the Covenant’. Unlike other world religions, a human community contracted with God, most especially through the man from Ur, Abraham (*Genesis* 17.2). Later, Jacob wrestled with the angel who would not reveal his name but instead named Jacob ‘Israel’ or ‘he who struggles with God’ (*Genesis* 32.28). With the appearance of Christ, the Covenant was arguably transferred to the Christian community and

then, with Mohammed, Seal or last of the Prophets, to the nation of Islam. The Covenant, beginning with the Jewish people, is a unique cultural artifact. In other religions, humanity is the plaything of the gods, not a contractual partner. A Person does not ‘struggle with God’, one simply accepts divine command. And unlike most other religions, the three great monotheistic faiths welcome converts. Quite simply, the biblical status of the Person is next to God and the individual human soul is the most precious ‘thing’ in all of creation. By analogy, from a biological perspective, the human mind is the most precious of all things in Nature.

6.3.2 The Code

1. Codified knowledge, as output, also comes in two forms: as intermediate and final good. Before addressing both, I must again distinguish my argument from current discussion and debate about codified knowledge. Unlike Romer (1996, 204) and others, I insist on a fundamental distinction between human-readable and machine-readable code. First, machine-readable code can never be a final output, *i.e.*, valued in-and-of-itself. It always remains a utilitarian tool serving a purpose other than itself. Second, the primary purpose of machine-readable code is information processing using the binary bit which, as demonstrated, does not provide a measure of knowledge (Boulding 1966). A third distinction is that “we can use words in a sense previously unknown to the linguistic community and make ourselves understood by means of the context for example, in using original metaphors” (University of Chicago, [Media Glossary](#), 2004). The complexity of such codes is captured by Roman Jakobson when he wrote:

No doubt, for any speech community, for any speaker, there exists a unity of language, but this over-all code represents a system of interconnected subcodes; each language encompasses several concurrent patterns which are each characterized by a different function. (Jakobson 1958).

2. Human-readable Code is semiotic in nature using signs, sounds, symbols and images including written alphabets that are ‘readable’ only with prior knowledge of cultural context. This sense is captured in Krystyna Pomorska’s “Tolstoy contra Semiosis” in which it is argued that Tolstoy’s “protagonist’s behavior [is] an attempt to supersede the artificial cultural code (behavior and speech) of his class and move into another code which is considered more natural” (Bagby & Sigalov 1987, 473). Cultural context, of course, extends beyond class to, among other things, the incommensurable paradigms of the natural & engineering sciences which require specialized knowledge and education to ‘read’ or decode. It is in this sense that Northrop Frye writes “man is a child of the word as well as a child of nature” (Frye 1981, 22)

3. Code invokes language – directly as the spoken or written word and indirectly as the language of sound or music, of image and shape, of motion or dance as well as body language

and dress. As demonstrated, however, language presents a meta-methodological problem for 'knowledge about knowledge'. Michael Polanyi highlights this problem by reference to the work of Evans-Pritchard concerning a tribal people, the Azande. They use a poison oracle to determine truth from falsehood. It proved impossible to reason with them because while: "They reason excellently in the idioms of their beliefs ... they cannot reason outside or against their beliefs because they have no other idiom in which to express their thoughts" (quoted in Polanyi Oct. 1962, 611, n15).

4. Code, excluding the spoken word, is extra-somatically fixed in a communications medium permitting access by another mind distant in time and space. As final and intermediate output, Code takes the form of articles, books, correspondence, magazines, technical and training manuals, memoranda, motion pictures, radio and television programs and sound recordings insofar as they are carriers of semiotic meaning. As will be demonstrated, it is the distinction between the non-utilitarian or utilitarian nature of the carrier or matrix that distinguishes Code, protected by copyright and trademark, from Tools, protected by patent and industrial design rights. Ultimately, however, every Code, as intermediate or final output, requires a Person to read and convert it back into personal & tacit knowledge.

6.3.3 The Tool

1. Like the Person and Code, the Tool takes the form of an intermediate or final economic output. A Tool involves fixing functional knowledge into a material matrix as a work of technological intelligence. Sensors and tools are intermediate and utilitarian artifacts while toys are final or non-utilitarian devices. And like a Code, a Tool is frozen knowledge and has vintage.

2. Choice of the term 'Tool' meaning 'instrument' (OED *tool*, n, 2a) allows escape from the traditional ambiguity between art and craft summed up in the Greek word 'techne'. Thus Aldrich (1969), like Kant and Aristotle before him, uses the term 'work' as in works of aesthetic or technological intelligence. As will be seen the term illuminates features shared by Code as a work of art and Tool as a functioning artifact. However, it also confabulates their differences, a Code carries semiotic meaning while a work of technological intelligence, or Tool, carries function. I will now examine the term 'work' to demonstrate such similarities and differences and justify my choice of the term 'Tool' as an output of the knowledge-based economy.

3. 'Work' is a very old English word. It is both a noun and a verb. As a noun it has three branches with thirty-five meanings and over sixty sub-meanings. The first branch refers to

something to be done, something being done, or something already done by an agency – divine, human or mechanical (OED, *work*, n, I). The second branch refers to the thing done or made or constructed including works of art, machines and buildings (OED, *work*, n, II). This sense also reflects ‘the effect or consequence of agency’ (OED, *work*, n, II, 9 b). The third branch involves ‘work’ in phrases such as workplace (OED, *work*, n, III).

4. As a verb, work has three branches with forty meanings and over 100 sub-meanings. The first branch, as a transitive verb, refers to construction, creation, design, direction, execution, herding, making, management, manufacturing, performing or producing anything from works of art and books to buildings and miracles. The second, as an intransitive verb, refers to the action, agitation, effect, fermentation, influence or other operation of an agency – divine, human or mechanical - in doing or making something. The third deals with work in relationship to adverbs such as work in, work with, work off, *etc.*

5. Four additional definitions of work are required: philosophical, biological, mechanical and economic. First, Heidegger defines work as “that which brings hither and brings forth into presencing, and that which has been brought hither and brought forth” (Heidegger 1954, 160). He etymologically links both the English and German for ‘work’ with the Greek ‘*ergon*’ from which the modern word ‘energy’ derives. That which is brought forth out of concealment into our presence by work Heidegger calls ‘reality’. In this sense ‘work’ means ‘making real’ that which was concealed or implicit.

6. Second, the biological concept of work as expressed by Kauffman (2000, 49) is ‘the constrained release of energy’. Thus,

the coherent organization of ... constraints on the release of energy ...
constitutes the work by which agents build further constraints on the release
of energy that in due course literally build a second copy of the agent
itself...” (Kauffman 2000, 72)

This concept also applies to works of aesthetic or technological intelligence which require the constrained release of energy for their creation, use or appreciation. In fact the constrained release of energy regulates the working of an instrument.

7. Third, in physics and mechanics ‘work’ means “the operation of a force [energy] in producing movement or other physical change, esp. as a definitely measurable quantity” (OED, *work*, n, I, 8). Arguably, as constrained release of energy, work also links with Heidegger’s technology given his interpretation of *energeia* in the Greek “enduring-in-work” (Heidegger 1954, 161) rather than the Latin concept of energy as efficient cause. In this sense, technology

fixes energy in physical structures (static or dynamic) enabling them, making them ready at hand to serve human purpose, to work for us.

8. Fourth, in economics, work is labour or “human effort, physical or mental, used to produce goods and services” (Mansfield & Yohe, 2004, A6). In the Standard Model, work is disutility, *i.e.*, pain, for which a worker is compensated by a wage used to buy goods and services from which to extract utility, *i.e.*, pleasure. Work is rewarded according to its disutility, *i.e.*, the greater pain, the higher the wage. Work in the ‘real’ world, however, is about much more than disutility and the real wage. Among other things, it is about motivation. If work is disutility then opportunistic behaviour can be expected, *i.e.*, slacking off. This is the implication of Leibenstein’s x-efficiency, *i.e.*, consumption in the act of production or how many coffee breaks does it take to make an unproductive worker (Leibenstein 1966, 1978, 1992)? But if work is not just disutility then ‘psychic income’ must be earned, *i.e.*, a worker receives satisfaction above and beyond the real wage.

9. Since the introduction of compulsory education in the Anglosphere (Bennett 2000) during late 19th century, vocational training, *i.e.*, training for work, has progressively crowded out ‘education’ meaning “culture or development of powers, formation of character” (OED, education, 4). Culture, in this sense, is the source of traditional ‘consumption skills’ (Chartrand 1987b) or appreciation, *i.e.*, “estimating qualities” (OED, appreciation, 2 a). In the pre-revolutionary aristocratic leisure society one’s social standing was a function of appreciation as well as birth. In this sense, growth of a leisure economy means increasing appreciation. Alternatively, a recreational economy means recreating the ability of workers to work.

10. Work has, of course, been subject to increasing division and specialization of labour since the time of Adam Smith generating increasing incommensurability of knowledge. Today in the Anglosphere, work, rather than culture, has become the focus of ego identity with skill specialization, rather than appreciation, the apex of ambition. How the social fabric is maintained in the face of such fragmentation is a question more fully addressed below. For now it is sufficient to note the influence of a political glue in the guise of republican egalitarianism and a communications nexus generated by pervasive mass media ‘public opinion’ creating and recreating consistent and coherent ‘pictures in our heads’ (Lippman 1922, 1).

11. Beyond the puritan and republican traditions of the Anglosphere, and in contrast to catholic and aristocratic traditions of continental Europe (Scitovsky 1976), crowding out of education reflected a need from the mid-19th to mid-20th centuries to develop repetitive industrial skills among an initially uneducated, rural labour force. While the deadening effects

of the division of labour may have been mitigated by mass education, mass education itself has its own associated costs:

We have paid a terrible price for our education, such as it is. The Magian World View, in so far as it exists, has taken flight into science, and only the great scientists have it or understand where it leads; the lesser ones are merely clockmakers of a larger growth, just as so many of our humanist scholars are just cud-chewers or system grinders. We have educated ourselves into a world from which wonder, and the fear and dread and splendour and freedom of wonder have been banished. Of course, wonder is costly. You couldn't incorporate it into a modern state because it is the antithesis of the anxiously worshipped security which is what a modern state is asked to give. Wonder is marvellous, but it is also cruel, cruel, cruel. It is undemocratic, discriminatory, and pitiless." (Davies 1987, 836)

12. By the late 1970s, Marshall McLuhan observed that the production skills in the new economy are non-repetitive, adaptive and judgmental invoking pattern construction and recognition - characteristic of traditional consumption skills. In this new economy, the worker/consumer becomes the 'electronic man' for whom "logic is replaced by analogy, and communications are... superseded by pattern recognition" (McLuhan, 1978).

13. Similarly, Robert Reich in *The Work of Nations* (1992) recognized that displacement of manual workers by automation and computerization combined with Third World 'off-shore' production was creating a new class of symbolic workers, *i.e.*, those who manipulate words, numbers, visual and other forms of codified knowledge. Also in 1992, the *World Competitiveness Report* observed that: "in the industrialized world today, only 15% of the active population physically touches a product. The other 85% are adding value through the creation, the management and the transfer of information" (World Economic Forum & Institute for Management Development 1992).

14. The dilemma of shareholders and managements in dealing with these new 'knowledge workers' is captured by Peter Drucker in his 1998 article "Beyond the Information Revolution". Quite simply, a higher real wage is not enough to satisfy such workers. Rather Drucker concludes that it is necessary to find some way of "satisfying their values, and by giving them social recognition and social power" (Drucker 1999, 57). In fact, a higher real wage may, contrary to the Standard Model, have a negative effect on a worker's "intrinsic motivation" (Schlicht 1998, 125).

15. In Hamlet's phrase "What a piece of work is Man" we also see that even individuals, Persons, design or 'work' themselves, *i.e.*, individuate (Sharp 1991), subject to cultural constraints. They are 'custom-ized' by and customize their culture, *e.g.*, to drive on the right or left (Schlicht 1998). Customs also appear subject to what Schlicht calls 'clarity criteria' that are

essentially aesthetic in nature including simplicity, regularity, conformity and conservatism. These criteria engage and reconcile the different knowledge faculties of the individual through, among other things, cognitive dissonance (Schlicht 1998, 12-13). One can identify distinct patterns of culture (Benedict 1959) and individuals ‘custom-ized’ to or by a specific culture.

16. Given the ambiguity of the term ‘Work’, I use the term ‘Tool’ to define a work of technological intelligence, *i.e.*, a sensor, tool and toy or an instrument. Works of aesthetic intelligence like a painting or sculpture are ambiguous in that extra-somatic knowledge is worked into a material matrix. What is tooled or fixed, however, is semiotic meaning not function. As will be seen, it is the distinction between a non-utilitarian or utilitarian matrix that distinguishes Code protected by copyright and trademark from Tools protected by patent and industrial design rights. Ultimately, however, a Tool requires a Person to operate it using personal & tacit knowledge.

6.4 Reconciliation

1. Ambiguity plagues analysis of knowledge due to its biological roots. Thus Code as an input involves extra-somatic encoding of knowledge into matter intended to be read by a natural Person while a Tool extends the senses and/or grasp of a natural Person. Computer and genomic software is tooled knowledge yet a code to be read by a machine or molecule activated by a Person. As an output, however, the natural Person is also a Tool, or a ‘work’ as in Shakespeare’s “What a piece of work is Man”, produced through education, experience and training. A work of aesthetic intelligence is also Code carrying semiotic meaning while a work of technological intelligence is an existential phenomenological extension of the senses and grasp of the natural Person.

2. For clarity, I restrict the term Person to the natural Person in whom personal & tacit knowledge is fixed as memory and reflex. I restrict Code to knowledge coded into matter or energy carrying semiotic meaning and Tool to knowledge fixed in matter or energy carrying function. Both Code and Tool, however, attain meaning or function only through the agency of a natural Person. Therefore, ultimately, all knowledge is personal & tacit.

3. Conversion of codified and tooled knowledge into personal & tacit knowledge remains, however, to be examined. With respect to Code, in pre-literate societies knowledge was transmitted orally through the mnemonics of ritual. Innovation depended upon the initial insight of the creator *plus* the ability to maintain mnemonic integrity through Time and Space, *e.g.*, as incantation or poem. Things changed but stayed the same with codification especially with innovation of writing and discovery of the Literary as well as the Media, Performing and Visual

Arts. First, author and receiver *must* share the same Codes and sub-codes, *e.g.*, alphabet, grammar, syntax, *etc.* Second, the ability of the author to convert thought into words or images or sounds and the ability of the receiver to convert them back into thought is limited. Similarly, the extra-somatic matrix carrying meaning is limited, *e.g.*, acid-based paper.

4. This, of course, was Harold Innis' great insight (Innis 1950). He viewed different communications matrices as carrying knowledge through Space and Time with varying degrees of efficiency. Innis is arguably founder of the only indigenous Canadian school of economics and came to his critical yet implicit conclusion after developing his 'staple theory' of economic development. He had studied Canada - from cod, to fur, to timber, to wheat. It was only then that he moved into 'communications' and the matrix (Innis 1950, 1951). Each staple, according to Innis, brings with it a distinctive patterning to the economy. His conclusion, expressed in my words: Personal & tacit and codified & tooled knowledge are the staple commodities of a global knowledge-based economy.

5. With respect to Tools, it has always been, since *homo habilis*, practice, talent and technique in performance or what Polanyi calls "indwelling". Tools permit the indwelling of a human being in an extra-somatic instrument or, more generally, in the technology that enframes and enables us. It is, in effect, the primal human "out-of-body experience". With a Tool we extend consciousness outward from our psychic centre to monitor and manipulate matter and energy. It becomes, with practice, part of us, an existential phenomenological extension of our very being. With the right Tool in the right hands, 'you' are 'there' be it Jupiter or Mars or the smallest particles of matter or the genetic structure of living things including the human genome. Instruction manuals may help but it is hands-on experience that converts tooled knowledge into personal & tacit knowledge. This is why Aldrich writes: "Technological intelligence does not come to rest in the eye or the ear. Its consummation is in the hand (Aldrich 1969, 382)." This, of course, means touch, a contact sense condemned by traditional aesthetics and the Positivists.

6. An important qualification must be added, however. At the microscopic and macroscopic scale it is only the instrument that can sense and manipulate matter and energy, not the human hand. It is representation by an instrument, *e.g.*, a cloud chamber or Geiger counter, that becomes the objective reality constituting what Idhe calls 'instrumental realism' (1991). And this reality is increasingly visual rather than tactile in nature. This is consistent with Heidegger's finding in his 1938 essay "The Age of the World Picture" where he stresses how representation beginning with Renaissance perspective has lead to our modern concept of objectivity. The representation or model becomes the reality: Seeing is believing! For now, however, I must turn to the final cause of knowledge - content, or what we want to know.

7.0 KNOWLEDGE AS CONTENT

1. I have argued that the biological human need to know is the material cause of knowledge and that Science by Design is its efficient cause while its formal cause is personal & tacit knowledge embodied in a natural Person as bundles of neuronal memories and muscle & nerve reflexes. What remains to complete a theory of knowledge is its final cause.
2. For Goethe, the “desire of knowledge is first stimulated in us when remarkable phenomenon attract our attention” (Goethe 1810, li). In Grene & Depew’s philosophy of biology (2004), the desire to know arises when an affordance attracts our attention or when an environmental invariant changes forcing us to adapt. In terms of Thomas Kuhn’s philosophy of science, the affordance involves the puzzle-solving of ‘normal science’ while a change in an invariant involves the paradigm shift of ‘revolutionary science’ (Kuhn 1996). No longer subsidiary, the changed invariant or environmental change becomes a focal concern, *e.g.*, global warming.
3. Having pursued the need to know through Science by Design it is, I will argue, the content of the knowledge so acquired, rather than its form as memory and reflex, that constitutes the final or teleological cause of knowledge. It is the ‘what, why, when, where and who’ about an affordance or changed invariant that completes our search. To sum up: the biological need to know is the material cause of knowledge, Science by Design is its efficient cause; the Person is its formal cause; and, content is its final cause.
4. Such treatment is consonant with Heidegger’s interpretation of causality in its original Greek sense of indebtedness, one to the other, *i.e.*, the four causes – material, formal, efficient and final - are “all belonging at once to each other, of being responsible for something else” (Heidegger 1955, 7). It is also consonant with his interpretation of final cause, or *telos*, as that “which gives bounds, that which completes” (Heidegger 1955, 7). Content completes the puzzle.
5. The content of human knowledge, however, is rapidly accelerating as the second Cambrian Explosion roars on. From biology, chemistry and physics to anthropology, economics and sociology to language, literature, music and religion to accounting, engineering, law and medicine, human knowledge is continually expanding. It is also becoming increasingly incommensurate, one field to the next. While the content of knowledge may be

incommensurable, the question becomes: Are there common or shared patterns for its presentation?

6. In effect, I applied trans-disciplinary induction (TDI) to search for commensurable sets or systems of ideas, *i.e.*, ideological commensurabilities, across seventeen sub-disciplines. The survey revealed such patterns. One already identified is gestalt knowing found in aesthetics, biology, economics, science and technology. Others will be presented in due course. For now, however, I present one to permit taxonomical comparison concerning ‘knowledge about knowledge’ across domains and disciplines.

7. This common pattern is a qubit or four-fold unit of knowledge. The traditional binary bit of information theory (0, 1), ‘on-off’, is extended and alternatively expressed as: (0, 1, 2, 3) or (1, 2, 3, 4). Explicit in sub-atomic physics, genomics and analytic psychology, the qubit is an ideological rather than a substantive pattern. Simply put, the number ‘four’ appears to be a descriptive common denominator for the organization of knowledge. One can only speculate why the human minds likes to see things in fours, *e.g.*, Pythagoras’ Tetraktys, Aristotle’s four-fold causality, the four Gospels of the Christian New Testament, *etc.* Causally, perhaps, the qubit is an artifact of carbon-based life with its chemical valence of four. If life, as we know it, is rooted in the number four then it should not be surprising that as cognitive carbon-based beings we would tend to pattern knowledge using the number four. Such thinking – linking psyche to physis -was in fact pursued by Carl Jung and Nobel Prize physicist Wolfgang Pauli (Meier, 2001). Alternatively, the qubit may be an acausal, coincidental or synchronistic product of the human mind. Whatever may be the case, the qubit will serve as a metric to summarize findings of ‘knowledge about knowledge’ in six disciplines of thought: economics, epistemology, etymology, law, pedagogy and psychology.

8. First, I will establish the presence of the qubit in physics, genomics and analytic psychology. Second, I will demonstrate a possible modeling of the qubit, *i.e.*, how it expresses the content and context of knowledge. Third, I will examine in detail the content of the six disciplines of thought noted above and summarize or reduce my findings to qubits that will subsequently be used to assess the competitiveness of nations in a global knowledge-based economy.

9. First, in sub-atomic particle physics the quark is the smallest known structure of physical nature. Quarks combine to produce a field effect called hadrons, *e.g.*, protons and neutrons (Nielson 2002). Weizsacker’s quantum theory of Ur-objects argues that the foundation of physical reality – the quark – can be operationally described as a qubit of information (Lyre 1995; Card 1996). That Weizsacker’s qubit is not just ‘theory’ is demonstrated by ongoing

efforts to develop the quantum computer based upon one implication of his theory – entanglement (*Economist* June 6, 2002).

10. Second, in genomics DNA is based on combinations of four nucleotides made up of adenine (A), thymine (T), guanine (G) and cytosine (C). These are always paired A-T or C-G. A sequence of three pairs is called a codon encoding an amino acid. Amino acids, in turn, combine to form proteins “the molecular machines of life” (Hood 2002). Current understanding of the Central Dogma of molecular biology indicates that the genetic machinery is dynamic and will respond to environmental signals that can modify the DNA bases (*e.g.* methylation of Cytosine), messenger RNA (*e.g.* slicing of introns) and proteins (*e.g.* post-translational glycosidation). That the genomic qubit is not just theory is demonstrated by efforts to develop DNA computers which run “more than 100,000 times the speed of the fastest PC” (Lovgren 2003). The genomic machine-readable code is also, of course, used to manipulate the chemical bonds of atoms and molecules to analyze or synthesize biological compounds and living organisms with intended or designed characteristics. Such code is fueling the development of a whole new spectrum of scientific instruments (Hood 2002).

11. Third, in his study of the human psyche – patients as well as the myths, fairy tales and ‘black arts’ of human cultures throughout history and around the world – Jung uncovered that four is “the minimal number by which order can be created” (Jung 1966, 46). He called this ‘the quaternary’ or ‘union’. He also identified four basic ways of knowing consisting of thinking, intuition, feeling and sensation – the results of which combine to generate human consciousness. That these four ways of knowing are not just ‘theory’ is demonstrated by the fact that they have spawned one of the most widely used psychological testing instruments in the world: *The Myers-Briggs Type Indicator*®.

12. The qubit can arguably be used to model or pattern the content and context of knowledge. The following brief sketch demonstrates how. Anticipating the next section, in English, there are four different etymological ways ‘to know’ by the senses, mind, doing, and experience. This I will call the ‘WIT’ in honour of Kenneth Boulding (Boulding 1966). There are five ‘pure’ cases : (1, 0, 0, 0), (0, 2, 0, 0), (0, 0, 3, 0), (0, 0, 0, 4) & (1, 2, 3, 4). In most cases, I suspect, more than one but less than four gates will be open, *e.g.*, (0, 2, 0, 4) or, to know by the mind and experience, *e.g.*, re-processing memories.

13. While absence (0) is clear, presence is not. Rather a coordinate may vary in intensity. And, like quarks, qubits are entangled. In physics this means, among other things, that having been in physical contact at one point in time they remain connected or entangled when separated in Space and Time. It is entanglement that provides the foundation for quantum computing.

14. I now turn to the content of knowledge in etymology, psychology, epistemology, pedagogy, law and economics which I will reduce to qubits. I will not, however, attempt to operationalize them at this time. Nonetheless I will subsequently use the qubit as the foundational unit for the production function of a knowledge-based economy. In effect, any piece of knowledge – personal & tacit, codified or tooled - may be classified by reference to the six resulting qubits.

8.0 ETYMOLOGY

1. Michael Polanyi's theory of personal knowledge extends beyond focal/subsidiary use of tools to language. Polanyi argues language is a pointer "to attend to what it points at, and this is its meaning." What language points to and its associated meaning becomes, for Polanyi, "a gestalt-sign". Due to psychological displacement or "partial transposition of this experience to a distance", the object of our attention becomes what we mean (M. Polanyi Oct. 1962, 605).
2. If, however, we shift attention from what language points to and concentrate instead on the pointer, *i.e.*, the elements of speech, then the meaning of the thing is lost. As long as language stays subsidiary it is transparent and the "transparent word is like a telescope through which we see its meaning". To make explicit such tacit knowledge is to destroy the sign-gestalt (M. Polanyi Oct. 1962, 605).
3. To extend the telescope metaphor, there are many different types of telescopes – optical, radio, infra-red, ultra-violet, *etc.* Similarly, there are many different human languages, each of which, however, including mathematics (Boulding 1955), is subject to inherent conceptual and other limitations, *i.e.*, to distortion of meaning. This is certainly the case with English, the language of this work. Knowledge, as a Platonic abstract noun, is arguably transparent and its meaning appears self-evident - if we do not attend to the origin and meaning of the word itself, *i.e.*, its etymology.
4. In what follows I will first place the 'word' in the context of language and then provide a detailed etymology of the words 'to know', 'knowledge' and related terms in English. The fact that in the seventeen sub-disciplines surveyed for 'knowledge about knowledge' there was no etymology of the word highlights how it is treated as a Platonic abstract noun in English. Nonetheless I recognize that some readers will find a string of definitions tedious and may, with a resulting loss of detail, shift their attention, after section 8.1 *The Word*, to section 8.3 *Reconciliation* for my conclusions about 'knowledge about knowledge' in English.

8.1 The Word

1. To know knowledge in English, one begins with the word. A word, of course, is part of a language that in turn is the foundation of the traditional 'nation' or 'people', *e.g.*, the Chinese, English, French, German or Japanese language, nation and/or people. In turn, 'language' derives

from the Latin *lingua* meaning ‘tongue’, *i.e.*, speech or “oral expression of thought or feeling” (OED, *language*, n 1,1a). In addition to words or vocabularies, languages differ in their grammar including their syntax, *i.e.*, the ordering of words, and, when reduced to writing, they differ in alphabet (phonetic) and/or script (ideographic), *e.g.*, Cyrillic, Kanji, Mandarin, Roman, *etc.*, and, arguably, mathematics.

2. Spoken and written language is a defining feature of our species. It is the primary but not exclusive means by which human knowledge is expressed and exchanged between individuals and across generations. Sometimes, however, as with the Logical Positivists, language is treated as synonymous with knowledge leading to other forms being ignored or denied. Baird calls this “semantic ascent” (Baird 2003, 8). Nonetheless, “if language-in-use is this all-embracing sort of activity, stylizing most of our other activities as human beings, then man is best defined, not simply as a rational animal but as *animal symbolicum* - the language-using animal” (Aldrich 1969, 389).

3. Since the mythic Tower of Babel, language has served to define a nation. Within a nation, a common language serves to build community, trust and understanding; between nations language creates alienation, confusion, and/or suspicion. If the primary vehicle for the creation and transmission of knowledge – language – is subject to systemic bias then what one means by ‘knowledge’ differs according to one’s language. And, as noted by the Middle East scholar Bernard Lewis: “Even accurate translation may be misleading, because in different cultures we use the same word with different meanings. There is a great danger of misunderstanding” (Lewis 2004).

4. To cite an example: Kawasaki in his analysis of science education notes that in Japanese there are no proper nouns in the Platonic sense of ‘idealized forms’ (Kawasaki 2002). Hence abstract concepts such as ‘the computer’ or ‘acceleration’ have meaning in Japanese only as specific experiential cases, not as abstract idealized forms. He suggests this may explain why the Japanese have excelled in technological innovation but lagged in the pure sciences. In contrast, the presence of abstract idealized nouns in English may explain why in my survey of seventeen sub-disciplines there was no etymology of the word ‘knowledge’. In effect, it is treated as a universal, not as a particular. But the word ‘knowledge’ is, as will be demonstrated, particular to the English language.

5. Accordingly, a comparative etymology in all major languages, *e.g.*, Arabic, Chinese, French, German, Japanese, Russian and Spanish, is required to provide insight into the nature and meaning of ‘knowledge’ in a global knowledge-based economy. Ideally, a comprehensive

comparative etymology would embrace all secondary, declining and even extinct languages. For present purposes, however, I restrict myself to English and to the origin and meaning of four words: can, know, knowledge and wit followed by a survey of related and imported words. I will then attempt a reconciliation of their meanings. I draw primarily upon the *Oxford English Dictionary* (OED 2004) except for a few words whose etymology I derive from the *Merriam-Webster Dictionary* (MWO 2004) including the word ‘science’.

8.1.1 Can

1. The verb ‘can’ derives from the same root as ‘to know’, the old English *cnáw* (OED, *can*, v, etymology). The Old Teutonic sense was “to know, know how, be mentally or intellectually able” from which the sense “to be able generally, be physically able, have the power” derives. This sense of ‘know’ apparently derives from an even early meaning of “I have learned, I have attained to knowledge”. The ‘know’ sense of ‘can’ has, however, been absorbed by ‘know’ as in ‘know-how’ (OED, *can*, v. Significance, II, 3). By contrast, in German, this meaning is retained by a separate verb *kennen*. In this sense, much discussion about the ‘knowledge-based economy’ is actually about a ‘know-how’ or ‘can-do’ economy.

8.1.2 Know

1. The word ‘know’ takes the form of a verb and two nouns in English. As a verb, it has ancient Teutonic and Aryan roots but is retained only in English. As has been seen, it shares its root *cnáw* with ‘can’ (as in ‘know-how’) and also with the obsolete English verb ‘ken’ meaning “to make known, to impart the knowledge” which in Scandinavian displaced ‘to know’ (OED, *ken*, v.1, 2). Know, in English, also absorbed the territory of the archaic English verb ‘wit’, the root of the German *wissen* – to know. In fact, the English verb ‘know’ covers meanings expressed by two or more verbs in other Teutonic and Romantic languages, *e.g.*, in German *wissen*, *kennen*, *erkennen*, and (in part) *können*; and in French *connaître* and *savoir*.

2. The OED notes that one group of scholars propose two distinct acts of knowing: *knowing by the senses* and *knowing by the mind*. The first means to perceive or apprehend; the second, to comprehend or understand. The first derives from the Old English ‘know’ while the second derives from the archaic ‘wit’. Alternatively, another group of scholars proposes that the only proper object of knowing is a fact or facts derived by reason (OED *Signification* 2003) in contrast with ‘to believe’ with its sense of emotional rather than intellectual certainty (OED, *know*, v, III,10a).

3. The verb 'know' has five branches (I-V) with 56 different meanings and sub-meanings. Each branch begins at about the same time in history. Within each meanings are presented in the OED sequentially through time (OED, *Preface to the Second Edition* (1989) General explanations, III. The signification, or senses). The first branch (I) is rooted in the Old English 'know' and involves knowing by the senses primarily meaning 'to perceive'. The second (II) corresponds to the French *connaître* and the German *kennen* meaning 'to be acquainted with' including sexual intimacy or carnal knowledge. The third (III) is rooted in the archaic English verb 'wit' and involves knowing by the mind corresponding to the French *savoir* and the German *wissen*. The fourth (IV) is rooted in the Old English verb 'can' meaning 'know how'. Finally, the fifth (V) involves use of 'know' with prepositions such as know about, know of, etc.
4. 'Know', as a noun, takes two forms. The first is rooted in the early Middle English *cnáw* and is related to contemporary use of 'acknowledgement' and 'confession'. The second is a recent formulation meaning 'in the know'.

8.1.3 Knowledge

1. The word 'knowledge' takes the form of a verb and a noun. The OED notes that the origin and relationship between 'knowledge' as a verb and noun is problematic but concludes that the verb appeared first. As a verb 'knowledge' has ten meanings and sub-meanings. The oldest (and obsolete up until now, perhaps) has specific significance for a knowledge-based economy: 'to own the knowledge of'. Other obsolete meanings include 'acknowledge' and professional recognition, *e.g.*, in medicine and law.
2. As a noun 'knowledge' has three branches and twenty-five meanings and sub-meanings. The first branch (I) involves the early sense of 'know' as a verb, *i.e.*, acknowledgement, recognition and legal cognizance. The second (II) involves later uses of the verb and involves (i) the fact or condition of knowing as in 'acquaintance' including sexual intimacy; and (ii) the object of knowing as information, intelligence, the sum of what is known, branches of learning including the arts and sciences, and a sign, mark or token of identity. The third (III) involves the use of 'knowledge' in combinations such as knowledge power and knowledge base, *i.e.*, the underlying set of facts, assumptions, and inference rules used in a given discipline of thought.

8.1.4 Wit

1. The word 'wit' takes the form of three verbs, a noun and a pronoun. The first use of the verb 'to wit' is archaic except in law where it stands in a formula after the place name of the

venue for a trial. In general, its archaic meaning of ‘cognizance’ or ‘knowledge of’ has been absorbed by ‘to know’. The second use is obscure in origin meaning ‘to bequeath’. The third is current and relates to ‘playing the wit’.

2. The OED traces four branches of ‘wit’ as a noun with thirty-four meanings and sub-meanings. The first branch (I) denotes a mental faculty. The first meaning is ‘the seat of consciousness or thought, the mind’ (OED, *wit*, n, I, 1). The second involves the faculty of thinking while the third involves faculties of perception “classified as outer (outward) or bodily, and inner (inward) or ghostly” (OED I, 3a). The fourth and final meaning under the first branch concerns the condition of understanding or mental capacity, *e.g.*, sanity as being ‘in one’s right wit’. The second branch (II) involves ‘wit’ as a quality, *e.g.*, of great mental capacity, wisdom, quickness, quality or lively fancy. The third (III) is chiefly obsolete involving senses corresponding to the Latin *scientia* and *sentential*. Meanings include learning, departments of knowledge or science as well as the way of thinking corresponding to ‘mind’. This is the sense of the German *wissenschaft* meaning learning, science or scholarship. The fourth and final branch (IV) involves the use of ‘wit’ in combination with other words such as at my wit’s end, wit-loss and wit-jar “an imaginary vessel humorously feigned to contain the wits or senses” (OED, *wit*, n, IV, 14e). As a pronoun, ‘wit’ has an obscure relationship to the pronoun ‘we’ as in ‘we two’.

8.1.5 Related & Imported Words

1. There are several words in English directly related to ‘knowledge’. Many have been imported from other languages. They can be grouped according to ‘know by the senses’ and ‘know by the mind’. The first category – to know by the senses – includes the words: apprehension, conception, perception and science. Apprehension derives from the French meaning to seize or grasp. Conception derives from the Latin *concipere* ‘to conceive’ that, in turn, comes from ‘to take in’ and, as I understand it, colloquially, meant ‘to grasp firmly with the hand’ or, in contemporary Sicilian, ‘to steal’. Thus ‘a concept’ is a grasping and manipulation with a mental hand. Perception derives from the Old French out of the Latin meaning ‘to take or receive’. Science literally means ‘to know’ and derives from the Latin *scientia* compounded from *scindere* ‘to split’ or ‘to know’ with the Latin suffix *entia* that forms nouns of quality (a word derived from the Latin for ‘kind’), *i.e.*, science involves splitting into kinds, types or taxonomies (MWO, *science*, n). Arguably, this is the etymological root of reductionism in contemporary science.

2. What all four share in common is a grasping and manipulation of the world – inner or outer. In terms of evolution, using its opposable thumb to grasp and shape parts of the world into tools with which to then manipulate other parts, *e.g.*, to kill game or plant seeds. Arguably ‘to know by the senses’ involves translation of this original experience of external manipulation into internal psychic or mental manipulation. This sense of ‘to know’ relates to its fourth branch (OED, *know*, v, IV) rooted in the Old English verb ‘can’ meaning ‘know how’.

3. The second category – to know by the mind – includes the words: comprehension, cognition, thinking and understanding. Comprehension derives from the Latin, and like apprehension, originally meant to seize but in later refinements in Latin and in English took the meaning ‘to grasp with the mind’ (OED, *comprehend*, v, Etymology). Cognition derives from the Latin meaning “to get to know”. Its original English, and present philosophic meaning, is roughly “the action or faculty of knowing; knowledge, consciousness; acquaintance with a subject”. Suggestively, both the adjective and noun ‘cognate’ involve common descent either of a language or a bloodline. Thinking derives from the Old English and means “formation and arrangement of ideas in the mind”. Understanding derives from the Old English and is equivalent to ‘comprehension’

8.2 Findings

1. From the above, I can report three findings. First, as a verb ‘to know’ has absorbed many meanings of the archaic verb ‘to wit’. Thereby, ‘to know by the senses’, in English, has become conflated with ‘to know by the mind’. As a noun, however, ‘wit’ survives defining the seat of consciousness of a natural person. This distinction - knowing through the senses vs. knowing through the mind – arguably plays an important role in continuing distinctions between the Liberal and the Mechanical Arts, between Science and Technology and between Management and Labour.

2. In addition to absorbing ‘to wit’, ‘know’ has also absorbed the meaning of ‘can’ as in ‘know how’ or ‘can do’. It also retains its root meaning of to know by acquaintance, *i.e.*, by experience. Thus in English one verb carries at least four distinct meanings – to know by: the senses, the mind, the doing and the experience. In German, by contrast, there are separate verbs for each. The competitiveness implications of this semantic economy is arguably evident in the contrast between the tertiary educational structures in Germany with its wide spread pattern of industrial apprenticeship (Economic Council 1992) and technical universities and their relative absence in the Anglosphere. My personal interpretation is rooted in a perceived English

language bias reflected in the expression: *Gentlemen don't work with their hands*. By contrast, and based on personal observation, in both Germany and Sweden where a linguistic distinction between different ways of knowing is preserved, the expression would be: *One is judged by how well one does something, not by what one does*. Thus linguistic differences reflect cognitive differences in the meaning of 'to know' with potentially significant competitiveness implications.

3. Second, if closely related languages use different verbs for different senses of 'to know', then one can reasonably conclude they possess many nouns of subtle meaning not available in English. These meanings have become lumped together in English into a single word 'knowledge' that has become numinous with purpose but confusing due to its multiple meanings.

4. If one extends English etymological economy to more distant languages using scripts other than the Roman alphabet, then the distinct and subtle differentiations of 'knowledge' may simply not be capable of translation, *e.g.*, in Cantonese, Hindi, Mandarin, Russian, Thai, *etc.* It becomes 'local' knowledge specific to a nation, to a people, and available only for domestic exploitation in a knowledge-based economy. All polymorphous forms and linguistic expressions of 'knowledge' are raw inputs (and final consumer goods) in a knowledge-based economy. Given the rate at which human languages are becoming extinct, however, many subtle meanings of 'knowledge' are lost every year, perhaps forever. (Sampat 2001)

5. Three, two disconnected etymological findings need to be reported. The first set concerns the relationship between 'knowledge', 'ignorance', 'belief' and 'opinion'. Ignorance is quite simply "the want of knowledge" (OED, *ignorance*, 1a). And if 'knowledge' derives from reason then 'belief' derives from some other faculty yet is held with emotional certainty (OED *know*, v., 10a). Similarly, while opinion may derive from reason or other faculties it is held as a probability, not a certainty (OED *opinion*, n., 1a). The second set of observations involves the fact that the OED defines economy, economist and econometrician but not economics. Economy is defined as management of the household and an economist as the manager of that household. Econometrics is defined as application of mathematics to economic data or theories. While economics is not formally defined, political economy is: "originally the art or practical science of managing the resources of a nation so as to increase its material prosperity; in more recent use, the theoretical science dealing with the laws that regulate the production and distribution of wealth" (OED, *economy*, 3).

8.3 Reconciliation

1. There emerge four primary meanings for 'to know' by: (i) the senses; (ii) the mind; (iii) the doing; and, (iv) the experience. All are reconciled in an individual human being. They organically interact, *e.g.*, some people read best (know by the mind) when they can physically handle a text (know by the senses) rather than simply see it on a screen. Each sense, in turn, generates demand for knowledge-based goods and services. In this perspective, no aesthetic, moral, philosophic or scientific inhibitions apply to choice, *i.e.*, taste does not matter in that all tastes are admitted and thus one person's pleasure may indeed be another's pain.

2. In this regard, from a welfare economist's perspective, there are two types of social behavior. First are onerous activities not performed for inherent satisfaction but only for what they yield, *i.e.* work. Thus the disutility of work is compensated by a pay check. Second, there are activities that are the opposite of work. They give satisfaction to those performing them. In turn there are two types of such activities. The first are antisocial activities that give pleasure by inflicting pain or suffering on others. Social costs usually outweigh benefits because benefits are transitory while suffering is often long lasting or permanent. Then there are social activities that impose no physical burden or harm on anyone yet can give satisfaction or pleasure to all. They include the most benign and valuable of human activities such as love, learning and the Arts (Scitovsky 1989).

3. What matters, however, is that a human want, need or desire to know exists and thereby an economic opportunity is created for producers to satisfy that need, subject to limited means and the law. I will examine each in turn.

8.3.1 By the Senses

1. The physical senses of taste, touch, sight, sound and smell are the elemental means by which an organism knows its external environment and the state of its internal health. Ontologically, external stimuli affecting one or more of these senses tend to combine, over time and through experience, to form patterns recognized by the individual as pleasurable or painful. Phylogenetically, pre-programmed recognition of such pain/pleasure patterns may become engrammed into the genetic code of a species. At the level of the senses, an organism wants to know pleasure and avoid pain. From this elemental analysis one can deduce that in human culture pleasure industries will evolve to satisfy the need to know pleasure. Sex, drugs and rock'n roll are examples as are the perfume and food industries. Of course, knowledge of short-

term pleasure may have costs that cannot be fully assessed by the senses alone, *e.g.*, long-term physical or moral debilitation.

2. In this regard, aesthetics, custom and morality play a more critical role than law in defining what is too much or goes too far. For example, if one considers obscenity in the Anglosphere, the Christian past steps boldly forward as ‘community standards’. These limit what an artist may express without fear of criminal prosecution. And what are the heresies of which no one should speak? Generally, sexual and scatological functions of the human body - created in the image of God. Yet images offensive in the Anglosphere may be symbols of God's glory in others, *e.g.*, full-penetration displayed in paintings or sculpture in ancient Hindu temples. What is Christian sin (and until recently crime) may be Buddhist or Islamic virtue, and, of course, *vice versa*. Failure to respect tacit social constraints has doomed many international business ventures.

3. The physical senses exhibit acute subjectivity, *e.g.*, what is hot to you may feel cold to me. Perhaps the most significant social contribution of the Scientific Revolution was scientific instruments that measure physical sensations – touch, tastes, smells, sights and sounds - at levels of perception at, above, below and beyond our genetic endowment. They do so, after calibration, without intermediation by a human subject – poet, playwright, philosopher or Pope. Thus while it may be hot for you and cold for me, the thermometer objectively tells us *both* that it is 20 degrees Celsius. This development has had an immense metaphysical effect on Western culture. Before the instrumental experimental scientific revolution, truth and certainty were the domain of reason (logic) and/or revelation (religion); afterwards, with respect to the physical sense, they became the domain of the machine.

8.3.2 By the Mind

1. Mind is defined as the:

seat of awareness, thought, volition, feeling, and memory; cognitive and emotional phenomena and powers considered as constituting a presiding influence; the mental faculty of a human being (esp. as regarded as being separate from the physical); (occas.) this whole system as constituting a person's character or individuality. (OED, *mind*, n, 1, IV, 19a)

This roughly corresponds to the obsolete meaning of ‘wit’ as the: “seat of consciousness or thought, the mind.” (OED, *wit*, n, I, 1).

2. In a way, ‘mind’ is the secular expression of ‘soul’ or Descartes ‘ghost in the machine’. As previously noted, the uni-dimensionality of thought with Space folded up into Time produces, perhaps the sense of the ethereal, spiritual or transcendental. Nonetheless, whether a

divine spark or an epiphenomenon of brain structure resulting from circular causality, mind exists on a cognitive plane different from that of the physical senses. It relies on “inner (inward) or ghostly” senses’ (OED, *wit*, n, I, 3) captured by the equally obsolete word ‘inwit’ meaning, alternatively, ‘conscience or inward sense of right and wrong’ or, ‘reason, intellect, understanding; wisdom’ (OED, *inwit*, 1 & 2a).

3. As with the five outer or physical senses, each of the five inward senses – conscience, reason, intellect, understanding and wisdom – create wants, needs and desires to know. In turn this creates an economic opportunity for knowledge-based goods and services to satisfy such needs including the education, spiritual, self-help and science industries.

8.3.3 By the Doing

1. If to know by the senses derives from the original meaning of ‘to know’ and to know by the mind from ‘wit’ then to know by doing derives from ‘can’. Quoting Richard Feynman, Baird notes: “What I cannot create I do not understand” (Baird 2004, 113). Knowing by doing, however, involves the tacit knowledge of performance. The classic example in the philosophies of science and technology is the existential phenomenology of the hammer (Heidegger 1927; Polanyi 1962a, 174-75). This involves praxis or the “practice or exercise of a technical subject or art, as distinct from the theory of it” (OED, *praxis*, 1a). Such knowledge cannot usually be fully codified. Often, however, it can be demonstrated through apprenticeship programs and master classes. Even in the natural and engineering sciences much knowledge can be attained only through doing. This, for example, was the experience of Cambrosio in his investigation of hybridomas technology (Cambrosio & Keating 1988, 249).

8.3.4 By the Experience

1. To know by experience encompasses all three previous meanings of to know: by the senses, mind and doing. Experience involves memory as both neuronal bundles and the trained reflexes of nerve and muscle. In both pattern recognition is engaged. To know by the senses means, among other things to: “perceive (a thing or person) as identical with one perceived before” (OED, *know*, v, I, 1) as well as acquainted or familiar with (OED. *know*, v, II, 5) including sexual knowledge (OED, *know*, v, II, 7). With respect to ‘knowing by the mind’, an obsolete meaning of ‘mind’ is “the faculty of memory” (OED, *mind*, n, 1, 2).

8.4/ Qubit WIT

1. All four meanings co-exist, are entangled, in an individual human being. Each, however, generates distinct and sometimes conflicting wants, needs or desires to know. Each, therefore, offers distinct opportunities for producers to satisfy such wants.
2. Collectively, the balance or blend of these ways of knowing constitutes our first knowledge qubit, the WIT. It is a qubitic or four-fold measure of the meaning of knowledge in the English language, *i.e.*, by the Senses, Mind, Doing and Experience.
3. Given the importance of language in theories of knowledge, *e.g.*, Logical Positivism, the WIT is, by definition, a limited English language construct. In other languages there are probably senses of 'to know' expressed in English only with great difficulty, if at all. The Logical Positivists attempted to overcome this problem by restricting themselves to the language of mathematics. Mathematics, however, is a subset of language, not the other way around.

9.0 PSYCHOLOGY

1. As has been demonstrated, Gestalt psychology provides an epistemological link between aesthetics, economics and the philosophies of biology (Marjorie Grene), science (Thomas Kuhn and Michael Polanyi) and technology (Martin Heidegger). Modern psychology, however, like other disciplines of thought, has experienced significant speciation since its appearance in the late 19th and early 20th centuries. Today one can identify a range of formal psychologies including analytic, applied, child, clinical, comparative, developmental, differential, educational, experimental, Gestalt, humanistic, industrial, individual and physiological schools of psychology. For my purposes I will consider ways of knowing in the context of analytic and physiological or, more precisely, neuro-physiological psychology. Before doing so, however, a few more definitions are in order.

9.1 Definitions

1. Psychology's 'knowledge about knowledge' like Science by Design is dyadic with a physical foundation and psychic faculties for its acquisition. The first is 'hardware'; the second, 'software'. Alternatively, the brain inclusive of the central nervous system is 'wetware' (Rucker 1988), a neologism distinguishing biological or carbon-based artifacts (natural or genetically modified) from silicon-based computer systems or 'dryware'. I will first review findings from cognitive psychology about wetware and cognition, *i.e.*, knowing and then examine analytic psychology's model for its acquisition. Before doing so, however, I will first link the etymological WIT to psychological ways of knowing *via* the concept of 'faculty'.

2. 'Faculty' has several meanings including a branch or department of knowledge (OED, *faculty*, II, 6). For my purposes, however, two other definitions will serve. First, a faculty is "an inherent power or property of the body or of one of its organs" (OED, *faculty*, III, 3). In this sense, the human brain is the organ of knowing. Second, a faculty is "one of the several 'powers' of the mind" (OED, *faculty*, III, 4). The mind, as the seat of knowledge, hosts a number of distinct faculties. Etymologically, there are five inner senses, or *inwits*, including conscience, reason, intellect, understanding and wisdom (OED, *inwit*, 1 & 2a). With the exception of reason these terms have not previously been defined. Conscience is 'inner knowledge or consciousness' (OED, *conscience*, I); intellect is "the power of thought" (OED, *intellect*, n, 1); understanding means "capable of judging knowledge (OED, *understanding*, vbl.

n, 1b); and, wisdom is “soundness of judgement in the choice of means and ends” (OED, *wisdom*, 1a). Arguably, it is wisdom that economics seeks in studying the satisfaction of human wants, needs and desires with limited means.

3. Contrasting definitions of faculty - a power of the body or of the mind - correspond to knowing by the senses (wetware) and knowing by the mind (software). Both have significant economic implications. On the one hand, the pharmaceutical and medical technology industries address knowing through the physical senses, *e.g.*, Prozac altering brain chemistry and MRIs (magnetic resonance imagers) while the education and psychological testing industry address knowing by the mind.

9.2 Wetware

1. It was only in the 20th century that wetware was meaningfully addressed by neurophysiology, *i.e.*, the study of the brain and nervous system. In simple terms, the human brain has developed through a three-stage evolutionary process. First came the so-called Reptilian Brain whose nature was the subject of Carl Sagan’s *The Dragons of Eden* (1977). Sometimes called the ‘rectilinear or R-structure’ it includes the brain stem and its specialized extensions such as the medulla oblongata. It receives sensations from the nervous system – voluntary and involuntary - and regulates the involuntary system. Second, overlaying this primitive brain is the Mammalian Brain or cerebellum with its distinctive lobes – left/right, front/back. Finally, like wrapping paper enfolding the previous two, is the cerebral cortex, the grey ridged matter sometimes called ‘the human brain’ but which we, as a species, share with both the higher primates and cetaceans such as whales and dolphins.

2. Put another way, the human brain can be considered as a collection of dedicated modular units each adapted to deal with a particular set of problems. There are distinct modules for color vision, locomotion, language-acquisition, motor control, emotional recognition, etc. Each module developed through natural selection (Greene & Depew 2004, 340) complimented by their coevolution (Kauffman 2000).

3. In this regard, research over the last hundred years has revealed a lateralization of higher brain functions or faculties. In the simplest, and least controversial terms: the left lobe is responsible for speech; the right lobe for pattern recognition, the front or temporal lobes for reasoning; the back or occipital lobes for visualization. The latter involves not just physical sight but also imagination, *i.e.*, “that faculty of the mind by which are formed images or concepts of external objects not present to the senses” (OED, *imagination*, 3).

4. It has been recognized that imagination and creativity share a common neurophysiologic basis in the Arts and Sciences (Meyer, 1974). In both, creativity occurs when an individual steps beyond traditional ways of seeing, doing and making. This commonality has been recognized in Thomas Kuhn's analysis of scientific revolutions (1996, 89-90) and Erich Jantsch's design for evolution (Jantsch 1975, 18) and, more generally, in the coevolutionary process of a self-organizing universe (Jantsch 1980).

5. The creative process appears to be rooted in the lateralization of brain function. The left hemisphere is primarily responsible for cognitive activities relying on verbal information, symbolic representation, sequential analysis, and on the ability to be conscious and report what is going on. The right hemisphere, on the other hand, functions without the individual being able to report verbally, and is concerned with pictorial, geometric, timeless and nonverbal information (Hansen, 1981, 23). In this regard, noted economist Geoffrey Vickers writes:

I welcome the recent findings of brain science to support the common experience that we have two 'styles of cognition', the one sensitive to causal, the other to contextual significance. I have no doubt that the cultural phase - which is now closing - restricted our concept of human reason by identifying it with the rational, and ignoring the intuitive function, and thus failing to develop an epistemology which we badly need, and which is within our reach - if we can overcome our cultural inhibitions. (Vickers, 1977)

6. More controversial are the findings of Wilder Penfield (1975), founder of the Montreal Neurological Institute and Julian Jaynes (1978), a controversial Princeton neuropsychologist. Penfield after fifty years of neurosurgery concluded that the brain stem contains what he called the *centrencephalic system*, or programmer of the human computer. Thus, if parts of the brain are damaged, particularly prenatally, the programmer can, within limits, reassign tasks altering the assignment of functions. It is only, Penfield deduced, when this centre is extinguished that 'humanness' vanishes. Nonetheless, "the mind, I must conclude, is something more than a mechanism. It is, in a certain sense, above and beyond the brain. Although it seems to depend upon brain action for its very existence, it is still free" (Penfield 1969, 81).

9. In the case of Jaynes, his career led him to conclude that a right lobe brain centre (current function unknown) corresponding to the left lobe's Wernicke's Area or speech centre was once active. Given the centrality of language to knowledge such a finding could have important implications. Dormant in contemporary humanity - except in artistic inspiration (the Muse), the voice of conscience and the voices of the schizophrenic, this right lobe centre was, according to Jaynes, once active and controlling. It constituted 'the bicameral mind'. Auditory hallucinations - the voice of the king or god - guided behaviour, not ego consciousness. Jaynes concludes that the first writings were not read but rather heard as the voice of its author, *e.g.*,

with reference to the 18th century B.C.E. Code of Hammurabi (the first written legal code) “someone seeking redress... would come to the steward’s statue ‘to hear my words’ as the stele says” (Jaynes 1978, 198). He goes on to observe that in hindsight writing replaced the bicameral voice as the controlling social mechanism.

8. Up the social hierarchy the voice changed from one’s master to one’s lord to one’s king to one’s god. Ancient humanity was in thrall to a social or collective rather than ego consciousness. This, Jaynes believes, is a partial explanation for the engineering feats of the Beaker People (Stonehenge) and the ancient Egyptians in the Old World as well as the Olmecs and Mayas in the New. He compares the work effort of bicameral peoples with the intensity and continuity of effort characteristic today only of schizophrenics suffering compulsive behaviour disorders.

9. According to Jaynes, the bicameral mind broke down with the near synchronistic collapse of all the ancient civilizations in the Old World about 1500 B.C.E. - China, Crete, Egypt, India and Sumeria. He similarly explains the collapse of the New World empires of the Aztec and Inca, some three thousand years later, by silencing the bicameral voice through regicide. It was the assassination of the king/god/emperor rather than the military might of a relatively few soldiers equipped with horses, muskets, steel swords and canon that assured the Spanish Conquest over millions. In effect, when the voices stopped the people did not know what to do. One implication of Jaynes’ hypothesis is that ‘ego’ consciousness was not in the past, nor may not be in future, the dominant mode of human cognition. In this regard, he portrays science, or more precisely our compulsive contemporary search for scientific knowledge as a search for the certainty lost with our expulsion from a bicameral Eden.

10. Given the lateralization of brain function or faculties, the question still remains: how does the physical brain generate consciousness or mind? Put another way, how can a macroscopic state called mind result from the microscopic actions of brain cells or neurons? The answer proposed by Freeman is “circular causality” which “expresses the interrelations between levels in a hierarchy: a top-down macroscopic state simultaneously influences microscopic particles that bottom-up create and sustain the macroscopic state.”(Freeman 1999).

11. The transcendent result of circular causality is ‘Mind’ as distinct from brain in keeping with Penfield’s observation that mind is “in a certain sense, above and beyond the brain” (Penfield 1969, 81). Having proposed a possible physical mechanism for consciousness, however, does not answer the question of how does the Mind – as a distinct, higher order epiphenomenon – know? Furthermore, as suggested by the controversial findings of Penfield

and Jaynes, our understanding of brain function remains problematic at best. And, of course, controversy attends all study of altered states ([Russell & Chayefsky 1980](#)) of consciousness produced by psychotropic substances as in Aldous Huxley's *Doors of Perception* (Huxley 1954). Nor does a physical explanation resolve the meta-methodological dilemma of 'knowledge about knowledge'. I do not perceive the physical sub-structure or wetware of my consciousness. In my mind's eye, the conscious 'I' is the operator, not some component part. This operator, this 'wit', occupies "the seat of consciousness or thought"; it is the "mind" (OED, *wit*, n, I, 1) made by knowledge and learning (OED, *wit*, n, III, 11a). No matter if it is a divine spark, the result of circular causality or coevolution, the mind is an objective phenomenon that must be treated in its own terms if it, and the nature of knowing and knowledge, is to be more fully understood.

9.3 Software

1. For most of human history the operator was called 'the soul' or "the principle of thought and action in man, commonly regarded as an entity distinct from the body; the spiritual part of man in contrast to the purely physical" (OED, *soul*, n, 2a). For the ancient Egyptians there were multiple souls but for the ancient Greeks and Church Fathers, each human being had a single soul constituting a monad, an indivisible unity. While external entities like demons and angels might influence the soul, it was nonetheless the atomistic soul that faced the world and was responsible for the consequences of its thoughts, words and deeds.
2. Until the height of the European Enlightenment in the 18th century, the faculties of knowing (of whatever nature or constitution) were thus viewed as revolving around and at the service of an individual undivided conscious self. Arguably, it was Franz Mesmer (1734-1815) who first demonstrated that there was more than a monad at play. About 1772 he identified the phenomenon of 'animal magnetism' that led to 'mesmerism', the precursor of hypnotism in modern psychotherapy. In Paris in 1778 he demonstrated this new phenomenon by curing diseases at séances. In 1785, however, when a commission denounced him as an imposter, he retired to Switzerland (A&E, [Franz Mesmer](#), Biography.com).
3. While Charcot (1825-93), Janet (1859-1947) and Krafft-Ebing (1840-1902) all explored beneath the surface of consciousness it is with Sigmund Freud (1856-1939) that the fissioning of the psychic atom is associated. Instead of a single 'I', the ego of the conscious individual was seen to be but one mental resident along with a personal unconscious, superego and id. The executive decisions of the ego could, therefore, be countermanded or frustrated by other players in a psychic drama leading from normality to neurosis to, at the extreme, psychosis. For Freud, however, the unconscious essentially contained only the suppressed content of personal

consciousness, *i.e.*, knowledge too painful to consciously bear. In this sense, ego was still in control.

9.3.1 Archetypes & Complexes

1. It was Freud's protégé, colleague and eventual rival, Carl Gustav Jung (1875-1961), who moved beyond the self- and socially-imposed constraints under which his one-time patron worked. Jung literally constellated the human mind with a myriad of unconscious forms and structures that are the common inheritance of all humanity – the collective unconscious. These are archetypes or “primordial, structural elements of the human psyche” (Sharp 1991) that affect consciousness in the course of daily life as well as in dreams, myths and fairy tales. Crystallized out of common elements shared by peoples across time and cultures they are called ‘mythogems’.

2. More importantly from a dollars & cents perspective, they can also be crystallized out into highly marketable products like ‘Star Wars’ and ‘Lord of the Rings’, *i.e.*, forms of commercial pattern recognition. The ‘wise old man’, ‘the hero’, ‘the witch’, ‘the lost treasure’, *et al* are archetypal roles, forms and images that exist in all human cultures and all human minds. On the stage of daily life these ‘complexes’ can, consciously or unconsciously, be donned like a costume by an individual playing with others (role playing). On screen, in literature, in painting and computer games, the audience individually identifies with or ‘knows’ these mythogemic elements and can, as Coleridge said of poetry, ‘temporarily suspend disbelief’ and play along.

3. Arguably, the star role today is played by ‘the ego’. This is certainly the conclusion of Erich Neumann, a student and colleague of Jung, in his exhaustive study: *The Origins and History of Consciousness* (1954). For Neumann, the ancient myths and religions show progressive development of the ‘hero’ as the carrier of individuality, *i.e.*, of ego consciousness. Ego consciousness has thus been an evolutionary struggle of one mythogemic complex among others for dominance.

4. Alternatively called analytic, complex, depth or Jungian psychology, analytic psychology draws heavily on Kant (1724-1804) including concepts such as faculties of knowing and a transcendent function. In simplified form, there are four morphological features to the Jungian model:

- a) Conscious/Unconscious: inhabited by distinct complexes or archetypes including the ego, all of which revolve around a transcendent called the Self;

- b) Introvert/Extrovert/Centrovert: direction of psychic attention;
- c) Thinking, Intuition, Feeling & Sensation: ways of knowing in varying dominant/subordinate configurations; and,
- d) Individuation: the teleological end of life as the realization one's true unique Self.

5. Each morphological structure competes for a limited supply of 'libido', *i.e.*, psychic energy. Freud viewed libido as sexual in nature; Jung saw it as the life force which ebbs and flows into many ports of call – sexual, intellectual, emotional, spiritual, *et al.* Accordingly, ego is in control only to the degree it can competitively appropriate sufficient libido. If not, then another complex may occupy the seat of consciousness as occurs in *participation mystique*, a “term derived from anthropology and the study of primitive psychology, denoting a mystical connection, or identity, between subject and object” (Sharp 1991).

6. Beyond its descriptive power, analytic psychology has spawned arguably the most widely used psychological testing instruments in the English-speaking world: *The Myers-Briggs Type Indicator*®. Used extensively in North American business and education it attempts to identify and measure the faculties of knowing possessed by an individual. The mix or 'type' reveals how each individual learns best, *i.e.*, acquires knowledge and best makes decisions. The implications for consumer and producer theory are self-evident. Decades of testing provide a potentially massive database for quantitative analysis (assuming ethical guidelines can be met and corporate owners are willing to share their results).

9.3.2 Faculties

1. For my immediate purposes only ways or faculties of knowing will concern us. I will reconcile Jung's four faculties – thinking, intuition, feeling and sensation – with an economic epistemology that would be familiar to Adam Smith: Reason, Revelation, Sentiment and Sensation. These terms are intentionally value-laden. They are meant to elicit or induce affect defined as “emotional reactions marked by physical symptoms and disturbances in thinking” (Sharp 1991). A connection between Adam Smith and Carl Jung can be drawn through the work of Immanuel Kant (1724-1804). Kant was a contemporary of Smith (1723-1790) with whom he shared the concept of faculties of knowing and, as noted above, Jung drew on Kant's concepts of faculties and a transcendent function. For each I offer an analytic psychology definition and contrast it with economic usage.

9.3.2.1 Reason

1. Reason must be reconciled with the psychological concept of thinking. Thinking is defined as the mental process of interpreting what is perceived. It is one of four functions used for psychological orientation or 'knowing' – thinking, intuition, feeling and sensation. Of these either thinking or feeling is usually dominant in an individual. Both are decision making faculties. In this sense, both are rational. Intuition and sensation tend to be subordinate to a dominant function while the remaining dominant tends to be suppressed becoming 'the lost treasure' in mythogemic terms. If thinking is primary, then feeling is automatically the inferior function. Higher order thinking rigorously excludes feeling and *vice versa* (Sharp 1991).
2. The guiding premise of economic epistemology is the rule of reason. In English, the word 'reason' entered the language in the 13th century and derives from the Latin *ratio* meaning computation and deriving, in turn, from *veri* meaning to calculate (MWO 2003). Hence mathematics, by definition, is the highest form of reason and reason as mathematical calculation dominates contemporary economics in the guise of calculatory rationalism. Nonetheless, non-mathematical linguistic-based logic also qualifies as Reason.
3. While Reason, as defined above, is narrower than thinking the archetypal symbol for thinking is the sword or knife, *i.e.*, something that cuts or splits into parts. Cutting through a problem is a metaphor for decisive thinking dating back to at least Alexander the Great's solution of the Gordian knot in 333 B.C.E. - a sword. And, as previously noted, the word 'science' derives from the Latin meaning 'to split'.
4. If there is, at the individual level, a human want, need or desire for 'reasoned', 'calculated' or 'reductive' knowledge, and, assuming circular causality is operative, then one would expect an industrial sector specializing in its satisfaction. This I will call the Science Industry inclusive of the natural and engineering as well as the social sciences to the extent that they apply calculatory rationalism.

9.3.2.2 Revelation

1. Revelation must be reconciled with the psychological concept of intuition. In analytic psychology, intuition is the function that perceives possibilities inherent in the present compared to sensation that perceives immediate reality. It is arational, *i.e.*, it does not explain or judge. It tends to be subordinate to a dominant function, usually thinking or feeling. Intuition gives outlook and insight into a garden of magical possibilities as if they were real (Sharp 1991).

2. In religion, Revelation refers to the disclosure of divine or sacred reality, purpose or truth. It may come through mystical insight, historical event, or spiritual experience that transforms the lives of individuals, groups and whole civilizations. The revelations of a Moses, Buddha, Jesus or Mohammed have incalculable social and economic effects ranging from changing patterns of consumption and international trade to geo-political conflict. More generally, and at the individual level, intuition refers to the power or faculty of attaining direct knowledge or cognition without evident rational thought and inference. In technological forecasting & assessment, this is called ‘no-knowledge’ (Jantsch 1967, 51).

3. It is important to note that in Adam Smith’s time (1776), the Church still claimed, but no longer effectively enforced, its monopoly on Revelation. The erosion of Church authority began in the 15th century when artist/engineer/humanist/scientist began to claim godlike powers of creation, *i.e.*, creating something out of nothing - *ex nihilo* (Nahm 1947, 1950). Their importance, however, extends beyond their works. They mark the eruption of the individual out of feudal subordination – a problem, as will be demonstrated, of acute concern to Smith. Most of these Renaissance giants claimed humble birth yet achieved noble ends – new knowledge, new creations. The ‘Cult of the Genius’ was born (Woodmansee 1984, 446, 47ff, Zilsel 1918]).

4. This, in turn, set the ground for the 16th century Protestant Reformation’s assertion of direct contact between the individual human soul and the godhead without intermediation by popes, bishops, clergy or philosophers. Freeing the individual from subordination to birth (the Renaissance) and from a clerical monopoly of revelation (the Reformation), the next step was political: the Republican Revolutions of the 18th and 19th centuries with their declaration that “all men are created equal”.

5. Even in the heartland of Reason, the natural & engineering sciences, Revelation or intuition, plays a critical role described by Thomas Kuhn as “scales falling from the eyes”, “lightning flash” and “illumination” (Kuhn 1996, 123). Of scientific revolutions he writes:

a new paradigm, or a sufficient hint to permit later articulation, emerges all at once, sometimes in the middle of the night, in the mind of a man deeply immersed in crisis. What the nature of that final stage is - how an individual invents (or finds he has invented) a new way of giving order to data now all assembled - must here remain inscrutable and may be permanently so. (Kuhn 1996, 89-90)

6. While Revelation may appear narrower than intuition it shares many of the same symbols, *e.g.*, ‘lightening flash’ and ‘illumination’. Religious metaphors in the West include ‘the burning bush’, the medieval English ‘Cloud of Unknowing’ (Progoff 1957) and Thomas Merton’s 20th century ‘Palace of Nowhere’ (Finley 1978). Furthermore, the contemporary role

of religion in geo-political competition – economic, political and military – should not be underestimated. The economic consequences of such knowledge cannot be ignored either. For example, in Israel and Islamic nations, the pork industry is virtually non-existent because of religion. The emerging genomics industry is differentially inhibited and encouraged for religious reasons, *e.g.*, fetal tissue research. Geopolitically, Revelation plays a central role in the ‘[Clash of Civilizations](#)’ (Huntington 1993). Even supposedly ‘secular’ states remain subject to the economic influence of religious Revelation:

A new Gallup poll shows that 48 percent of Americans believe in creationism, and only 28 percent in evolution (most of the rest aren’t sure or lean toward creationism)... Americans are more than twice as likely to believe in the devil (68 percent) as in evolution. (Kristof 2003)

9. To put it another way, from an economic perspective, God is real and means business, big business. If there is, at the individual level, a human want, need or desire for no-knowledge, psychic, spiritual or higher enlightenment, and, assuming circular causality is operative, then one would expect an industrial sector specializing in its satisfaction. This I will call the Spiritual Industry inclusive of religion and a myriad of psychic movements and communities as well as the ‘self-help’ movement.

9.3.2.3 *Sentiment*

1. The psychological term *feeling* also must be reconciled with economic usage. It is the psychological function that evaluates or judges what something or someone is worth compared with thinking that interprets what ‘is’. Both are rational functions. One or the other tends to be dominant in any individual – thinking type or feeling type. A feeling is as indisputable a reality as an idea ([Sharp 1991](#)). Feeling also leads to cooperation or opposition between individuals and groups.

2. Before the Marginalist Revolution of the 19th century, feeling or rather its economic cognate - Sentiment - played a complimentary role to Reason. It too, however, was displaced by Bentham’s hedonic calculus. In *The Theory of Moral Sentiments* and *The Wealth of Nations*, Adam Smith stresses the role of Sentiment in the dialogue of the marketplace, *e.g.*, what today is called ‘market trust’ (*The Economist* Feb. 20, 2003). To Smith, it was division and specialization of labour together with appropriate ‘market sentiments’ that best assured the wealth of nations. Douglas North defines such sentiments as “informal constraints” or “norms of behavior, conventions, self-imposed codes of conduct” ([North 1994](#), 360).

3. Sentiment means “an opinion or view as to what is right or agreeable” (OED, *sentiment*, 6a). In order to highlight the economic importance of Sentiment as a way of knowing I will briefly review Adam Smith’s attitude towards subordination of the individual and his ‘sentimental’ concern about the division and specialization of labour. I will then amplify these findings with a review of the work of cultural anthropologist Grant McCracken and economist Ekhart Schlicht.

Adam Smith

4. Adam Smith (1723-1790) can justly be called ‘the great mariner’. It was he who first navigated the limits of economics using what was, in his day, a branch of moral philosophy destined to become the first ‘social’ science - political economy. Economics, as a discipline of thought or “a recognized field of tooled knowledge” (Schumpeter 1954, 143) is generally dated from the 1776 publication of his *The Wealth of Nations*. The foundation for Smith’s concept of knowledge, however, was laid down in his other great work, *The Theory of Moral Sentiments*, published previously in 1759.

5. With time, some of Smith’s findings became axiomatic in economics; others, slipped into its murky depths waiting to be recovered by adventurous intellectual archaeologists. What fell, or was thrown into the water partially reflects the reactionary forces dominating political life after Smith’s death until the fall of empires in 1918. During his own life, he was considered, by many, a dissident, a friend of French *économistes*, a Jacobin, a revolutionary.

6. Consider the pre-revolutionary reception of *The Wealth of Nations* in France:

... some weeks before it was first published in London in March 1776. “Here is a strange adventure,” the abbé Morellet wrote to Turgot on February 26; he relates that as he was waiting, earlier in the day, for the proofs of his translation of “the piece by Mr. Smith” - a section of the early chapter of the *Wealth of Nations* dealing with corporations and apprenticeships - he received news that the manuscript had instead been seized by the police, and was deemed to be worthy of burning. (Rothschild 2001, 87)

7. Smith published just as the republican revolution in America (1776) was overthrowing the feudal order of subordination - an order under which some were created superior and others inferior by birth. The *Declaration of Independence* (1776) overthrew this old order with its premise: “We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness.”

8. Smith also lived to see the second republican revolution in France overturn the *Ancien Regime* of privilege replacing it with one of ‘liberty, equality and fraternity’. He did not,

however, unlike Bentham, live long enough to see both revolutions betrayed – the first by limiting the definition of ‘man’ to white males and the second by self-righteous revolutionary zeal excusing terror as an instrument of freedom.

9. Nonetheless, the view of the individual as the foundation of political life was shared by Smith and was consonant with his view of the individual as the foundation of economic life. In his day, there was in fact only one life. Politics and economics were, according to Smith, incestuously entangled - political power converted to economic profit and profit to political power. The regime of privilege in the form of feudal corporations including the Church, mastership guilds, towns and trading corporations was a fundamental impediment to the wealth of nations because it inhibited the individual in pursuing self-interest rather than that of his or her lord, lady or other superior above stairs.

10. Following the defeat of the French Revolution, the Congress of Vienna in 1815 created the ‘Holy Alliance’ of European monarchies to reinstate political and social subordination and repress republican sentiment among the population. In Britain (and America), however, Adam Smith’s successors, in his name, argued for business enterprise to be set free from the regulatory vestiges of the pre-revolutionary order. In effect, economic life was to be divorced from political life. Political power was no longer to be convertible into private profit, nor private profit into political power – in theory.

11. One economic axiom derived from Smith is ‘the division and specialization of labour is limited by the extent of the market’. Both imply knowledge. In the first instance, ‘know-how’ is required in the division of the production process and, in the second, specialized skills are required to efficiently realize an ever increasingly complex production process. Division and specialization of labour is the cornerstone of the *Wealth of Nations*.

12. To Smith, however, gains had to be counted against costs including what Marx would later call ‘alienation’. For Smith, division and specialization of labour led to a dangerous narrowing of the individual: “People are not born ‘stupid and ignorant’ but are made so by their ‘ordinary employments’; by the simple, uniform nature of the work they can get” (Smith quoted in [Rothschild 2001](#), 97). Smith’s answer was public education. The dialogue of the marketplace and the political arena required citizen workers who could read, write and count.

13. Moving from division and specialization of labour to that of knowledge, the market has now extended to global proportions. And, as Smith implied, there has been a narrowing of breadth and an increasing of depth with the individual becoming increasingly atomized, alienated or disinterested in all but a narrow but deep vertical slice of knowledge. This is

evident in the natural & engineering sciences where ‘normal science’ involves puzzle-solving attention to smaller and smaller fields of vision (Kuhn 1996). As demonstrated, this leads to incommensurability compounded by ‘just keeping up’. It is also evident in the Arts where the *Art-for-Art’s-Sake Movement* (Henderson 1984) generates an ever moving, shifting and changing *avant garde* (Bell 1976) spinning out ever increasing esoteric aesthetic messages intended for ever smaller audiences – *the cognoscente* from the Italian meaning ‘the knowing man’ (OED, *cognoscente*).

Grant McCracken

14. The interaction of Reason and Sentiment in economic behaviour is revealed in Grant McCracken’s 1988 study *Culture and Consumption*. McCracken begins by describing the birth of consumer culture. He argues that it was in 16th century England, in the court of Elizabeth I (not in the French court of Louis XIV a century later) that consumption was revolutionized. To keep Catholic and other nobles loyal in troubled times, she exploited the “hegemonic power of things to communicate the legitimacy of Her Rule”. Before Her Time, the family was the traditional unit of consumption. One bought for future generations. One bought that which would last because it took five generations of patina to move one’s family into the ‘gentle’ class. She, however, forced those aspiring to rise in station to spend now, for this generation - to be the prettiest peacock at court, the most generous. Like the potlach (praised as the quintessential example of “caring” capitalism by George Gilder in his influential 1982 paean to the Reagan Revolution entitled *Wealth and Poverty*) members of the court were compelled to consume their way to honour, power and gentility. It was rational to do so. This shift from long-term to short-term consumption had a dramatic impact on the evolution of Western culture contributing to the breakdown of feudal society. At the same time, however, punitive feudal sumptuary legislation remained in place, and was reinforced in continental Europe after the defeat of Napoleon, to restrict “status fraud”, *i.e.* persons of lower classes dressing or otherwise pretending to a higher station in society.

15. McCracken goes on to explore the subsequent English consumer revolution of the 18th century with particular emphasis on the role of Josiah Wedgwood in shifting the source of fashion (pattern construction) from the nobility to the bourgeois marketeer, or what McCracken calls “market ethnographers” who watched for patterns and regularities and adjusted products and marketing strategies to take advantage of emerging opportunities. By the 19th century such observers of English society attained unprecedented social mobility. Thus McCracken notes: “In the person of Beau Brummel we see nothing less than the abrogation of powers of influence that

had previously been possessed only by the monarch”. Today, of course, Hollywood and sports celebrities play a similar fashion-setting role – another incarnation of the cult of the genius.

Ekhart Schlicht

16. In his 1998 book, *On Custom in the Economy*, German economist Ekkehart Schlicht demonstrates that - despite Bentham’s conviction that it is not rational – custom is critical to the efficient operation of the economy – both on the supply- and demand-side. Using aesthetics and pattern recognition, Schlicht lays out the nature, persistence and economic implications of custom. By way of introduction he observes:

...custom affects motivation, conviction, and behaviour in such a perfectly ‘natural’ way that the customary undergirdings of social and economic processes appear hardly discernible, and sometimes even invisible. In spite of this imperspicuity, custom exerts, in Alfred Marshall’s words, a ‘deep and controlling influence over the history of the world.’ (Schlicht 1998, 1)

And, custom is not a child of Reason but of Sentiment.

17. If there is, at the individual level, a human want, need or desire for Sentiment and assuming circular causality is operative, then one would expect an industrial sector specializing in its satisfaction. This I will call the Arts Industry inclusive of the amateur, applied, entertainment, fine and heritage arts in all media of expression, *i.e.*, the literary, media, performing and visual arts (Chartrand April 2000). As will subsequently be argued, Art provides the technology of the heart; it manages and manipulates Sentiments.

9.3.2.4 Sensation

1. Sensation is the psychological function that perceives immediate reality through the physical senses compared to intuition that perceives possibilities. Both tend to be subordinate to a dominant faculty and are arational, *i.e.*, they do not involve interpretation or judgement (Sharp 1991). There are, however, individuals whose dominant faculty is sensation – the athlete, dancer, gourmet and arguably the mechanic as well as the drug addict, the debauchee, *i.e.*, “one who is addicted to vicious indulgence in sensual pleasures” (OED, *debauchee*) and, arguably, all ‘thrill seekers’.

2. Sensation is the most primitive faculty. It is also the most epistemologically problematic. Everything one knows about the external world (and about the state of one’s own body) is through the senses of taste, touch, smell, sight and sound. Excepting emergencies, in normal life what they tell us, however, – be it pleasure or pain - is subject to perception and

reflection including context, *e.g.*, knowing one was hit by accident and restraining one's response. This is the difference between the raw data of sensation and its meaning mediated by 'higher' faculties, *i.e.*, perception. Overcoming the pleasures of the physical senses has also been seen as critical for the good judgement of rulers. Thus over 2,000 years before Bill Clinton succumbed to the pleasures of Monica Lewinsky "because I could" (*CBS Evening News*, "[Clinton Cheated 'Because I Could'](#)", June 17, 2004), the Indian 'Machiavelli', Kautilya, wrote of the king:

he shall restrain the organs of sense; acquire wisdom by keeping company with the aged; see through his spies; establish safety and security by being ever active; maintain his subjects in the observance of their respective duties by exercising authority; keep up his personal discipline by receiving lessons in the sciences; and endear himself to the people by bringing them in contact with wealth and doing good to them. Thus, with his organs of sense under control, he shall keep away from hurting the women and property of others; avoid not only lustfulness, even in dream, but also falsehood, haughtiness, and evil proclivities; and keep away from unrighteous and uneconomical transactions. (Kautilya c. 250 BCE) Book I, Chapter 7, The Life of a Holy King, *The Arthashastra*, c. 250 BCE

3. As a subordinate faculty, Sensation is subject to excitation by a dominant one – usually thinking or feeling. This process is captured in Timothy Findley's 1999 novel *Pilgrim*, a fictionalized biography of Carl Jung. Very late at night, Jung tries to tell his wife a new intellectual insight when he realizes he is suffering from "intellectual priapism": "It's that simple. Get an idea - get an erection" (Findley 1999, 258). The point is that psychic faculties are entangled one with the other. They do not operate alone. They are dependent, one on the other.

4. Similarly with respect to religious art, Kenneth Clark in his classic text and BBC series *Civilization* demonstrates the subordination of Sensation to Sentiment by reference to Bellini's statue, *The Ecstasy of St Theresa*:

one of the most deeply moving works of European art... used to convey the rarest and most precious of all emotional states, that of religious ecstasy... in the supreme moment of her life: how an angel with a flaming golden arrow pierced her heart repeatedly: 'The pain was so great that I screamed aloud, but simultaneously felt such infinite sweetness that I wished the pain to last eternally. It was the sweetest caressing of the soul by God.' (Clark 1969, 191)

5. The primal or instinctoid drives of the Id had, in the Freudian view, been yoked and sublimated by the individual (super ego) and society (custom and law) to produce human civilization. In this regard, logic and reason are rooted in Western rejection of passion, *i.e.*, of the mind "being acted upon" by an external agency (OED, *passion*, n, II). Revelation, of course,

embraces passion, specifically in the West that of Christ (OED, *passion*, n, I, 1a). It rejects, however, passions of the flesh including the Seven Deadly Sins – pride, envy, gluttony, lust, anger, greed and sloth. I will now briefly consider the implications of Sensation in aesthetics, science and economics.

Science

6. Different individuals often interpret the same objective sensory data differently. Is it hot or cold? Is it pleasure or pain? Is it God or the devil? The Scientific Revolution, however, achieved something new. Robert Boyle during the 1650s placed the laws of the physical universe in stasis above and beyond the meddling of human and God (Jacob 1978). The act of Creation had, once and forever, established the Laws of Nature. Having set the machine in motion God withdrew and Nature became the legitimate object of the disinterested machines of experimental philosophy.

7. What the Scientific Revolution did was to introduce instruments that generate consistent, objective, quantitative measurements of physical sensation through time. They extend the human senses beyond the subjectivity of the individual observer. Once calibrated and set in motion a clock ticks at a constant rate per unit time until its energy source is exhausted. Such measurement is achieved without mediation by a human subject. In a manner of speaking the Scientific Revolution allowed the study of sensation at a distance – the distance and legitimacy afforded by scientific instrumentation. In the process, however, it can be argued that ‘instrumental’ perception in the natural sciences has been reduced almost exclusively to sight and to an ever narrowing ‘vision’ thereof (Idhe 1991, 41).

Aesthetics

8. Similarly, aesthetics traditionally restricts itself to the ‘distant senses’ of sight and sound. The contact senses of touch, taste and smell lead to obscenity, gluttony and scatology, or more generally, as noted by Berleant they destroy “the isolation of the contemplative mind” (Berleant Winter 1964, 187).

Economics

9. This distancing from the intimate subjectivity of the physical senses is thus shared by: (i) philosophy (a humanity) which isolates itself from the passions; (ii) religion; (iii) aesthetics which traditionally restricts consideration to the distant senses; and, (iv) science that segregates the observer from the observed through instrumentation.

10. Economics, however, is another question. In economics, Bentham's utile – the unit measure of pleasure/pain - is the foundation of knowledge with pleasure and pain acting as “the two sovereign masters of humanity” (Clough 1964: 825). One suffers the disutility (pain) of work to earn income to buy goods and services into which firms fix utility that is to be extracted by customers in final consumption (pleasure). Economics, so defined, is strictly hedonic and materialistic. Any and all sensations demanding satisfaction become a legitimate object of economic epistemology – no holds barred. In this sense, economics is an amoral science

11. In the Benthamite tradition, however, maximizing pleasure was restrained by the tenets of Ethical Hedonism, a very Protestant Ethic. This ethic, beyond concern with the moral value of work, also involved social inhibitions against conspicuous consumption (Veblen 1899). As noted by Daniel Bell (1976, 20-22), however, with the collapse of the Protestant Ethic after the Industrial Revolution, only hedonism remains - in all its unrestrained, irrational incarnations. Without a generally accepted moral code, the law became the accepted social mechanism to moderate individual pleasure-seeking. In fact, the Benthamite tradition in crime and punishment continues to guide both legal and economic research, *e.g.* Bentham's famous and seemingly plausible dictum “the more deficient in certainty a punishment is, the severer it should be” (Becker 1968).

12. If there is, at the individual level, a human want, need or desire to know sensation, and, assuming circular causality is operative, then one would expect an industrial sector specializing in its satisfaction. This I will call the Pleasure Industry inclusive of ‘sex, drugs and rock’n roll’ as well as the leisure, sports and food industries.

9.4 Qubit PSI

1. In each individual, all four faculties of knowing – Reason, Revelation, Sentiment and Sensation – function. Like quarks, they do not exist alone. There are no free faculties. Rather they exist only together uniquely embodied and entangled in the ‘self-awareness’, ‘consciousness’, ‘knowing’, ‘mind’ or ‘wit’ of an individual human being living in a particular place at a particular time and subject to different and varying social conditioning. For example, the itch for sensual knowledge may be satisfied or sublimated in different ways by Reason, Revelation and/or Sentiment. For Freud, this was the role of the super-ego. The yoking of libido or life force is the meaning of the word ‘yoga’. All major religions traditionally suppress and sublimate sensual needs in return for a promised afterlife. As has been demonstrated both Arts and Science have similarly restricted knowledge to the distant senses and repressed the contact ones – touch, taste and smell. Such sensual ways of knowing are immeasurable and

incommensurable and arguably best expressed through Art rather than mathematics. Finding out what is one's unique blend and balance of these different ways of knowing - oneself and the world - is the life passage Jung calls 'individuation'.

2. This uniqueness colours our individual use of faculties and defines how best we learn. In the words of James Hillman: "each person [is] the embodiment of an individual destiny" (Hillman 1980, 4). The entanglement of the four psychological faculties of knowing constitutes our second knowledge Qubit - the PSI which is some function of Reason, Revelation, Sentiment, Sensation.

3. This uniqueness, however, creates another meta-methodological dilemma. If knowledge exists only in a unique individual, then knowledge is unique and 'knowledge about knowledge' becomes comparatively impossible to obtain. The individual is, however, not just unique but also social. Bronowski captures the dualism of the human being as 'a social solitaire' (Bronowski 1973). Each individual shares faculties with other individuals. Uniqueness is an aesthetic, gestalt or image emerging from the blending, mixing and intensity of these faculties constituting the PSI, *i.e.*, Reason, Revelation, Sentiment and Sensation. It also reflects a *hieros gamos* or sacred wedding (Jung [1954] 1966, 5) of mind and body (knowing by the mind and knowing by the senses) that makes us a living human being. Whether animated by a divine spark or circular causality, to be human is to be married mind and body, or traditionally, body and soul. Divorce leads to death beyond which component parts fly apart whose final destination remains a matter of metaphysical dispute.

4. One of the great fears of analytic psychologists like Jung and Hillman, however, is that development of a typology of psychic faculties, functions and directions (introversion/centroversion/extroversion) required to recognize the uniqueness of an individual patient could be transformed into a tool of social control and conditioning, even in the hands of the psychologist:

If even psychology sees man as exemplifying typical functions, then there are no essential differences among human kind. We are functions, or functionaries, of groupings, an inventory of consumer tastes, actuarial probabilities, marketable skills, opinion. (Hillman 1980, 57)

9.5 Reconciliation

1. From cognitive psychology, we know that Reason resides somewhere in the frontal lobes; Sentiment in the amygdaloid nucleus; and, Sensation in the thalamus near the top of the brain stem. Further we know that the thalamus mediates the inflow and outflow (to our limbs) of our physical senses which are routed to and from higher order structures including the

amygdaloid nucleus and the frontal lobes (Freeman 2000). In this regard, the decision-making or executive function located in the frontal lobes appears to be always matched by an emotional response emanating from the interaction of the cerebellum and brainstem (Freeman 1999). This appears consonant with analytic psychology's findings about the judgmental role of thinking and feeling, *i.e.*, broadly defined, both are rational. To date, the structural location of Revelation or intuition has not been found but arguably it is associated with the visual cortex in the occipital or rear lobe of the brain.

2. To economics, however, the wetware configuration is of relatively little importance. What is important is that different faculties generate distinct human wants, needs and desires to know that producers can strive to satisfy. Thus unlike aesthetic distancing or scientific observation, no moral or methodological limitations are admitted to the PSI. All the senses – near and far, obscene and revelatory – are admitted even when they clash with calculatory rationalism. What matters is that human beings have a need to know and this takes many polymorphous forms.

10.0 EPISTEMOLOGY & PEDAGOGY

1. If ideology is the science of ideas then epistemology is the theory of knowledge and pedagogy is the theory of teaching. There are, of course, many different theories of both. Accordingly, ideology may be seen as an overarching limb from which hang so many epistemologies like fruit on the fabled tree of knowledge while pedagogy is the seed of its replication and transmission. What they share – ideology, epistemology and pedagogy - is a sense of the *social*. By contrast, the etymological WIT (knowing by the Senses, Mind, Doing & Experience) and psychological PSI (knowing by Reason, Revelation, Sentiment & Sensation) share a sense of the *individuation* of the natural Person. This highlights Bronowski's portrayal of humanity as a 'social solitaire' (1973) or Grene & Depew's "reflective privacy" (2004, 336). With respect to the latter, the individual human being can withdraw from society into a personal private psychic space where time flows backward, forwards and sideways, where space expands and contracts without physical movement, where one knows oneself *cum* Heidegger's *Being and Time*. And, it is here (and in one's body) that personal & tacit knowledge lives. It is only here that knowledge truly exists – personal & tacit.

2. Nonetheless, it is through sharing knowledge between Persons - through speech, codification, demonstration and/or tooling - that socially useful categories of knowledge – epistemologies – evolve to become the social genetic transmitted to future generations through pedagogy. For my purposes there are two primary epistemic/pedagogic categories: Domains and Practices. I will define and examine each in turn. Before doing so, however, a brief history of the Western university is in order.

3. The university both links and separates Domains and Practices. Arguably, the stereotypical medieval university was organized into three Domains: natural and moral philosophy and metaphysics or theology. To these liberal arts Domains, the Practices of law and medicine were from the outset appended. Together, these constituted the university.

4. This structure changed very slowly following the Scientific Revolution of the 17th century. With religious wars waging, the university – Protestant and Catholic – were busy defending religious doctrines and resisted the new experimental philosophy. In effect, the university remained a training ground for elites in traditional and proper ways of knowing. The first significant change occurred in the early 19th century with the first research university at the

University of Berlin (1809). The efforts of Wilhelm von Humboldt transformed the mandate of the university from interpretation of old to generation of new knowledge. In the process, the experimental natural sciences made the university their home.

5. Thus from the 17th century, the experimental sciences existed outside the university proper acting like an ‘emergent process’ (Emery & Trist 1972, 24-37). First through concealment and latter by parasitism, the natural sciences gradually entered the university, absorbed more and more of its resources (financial and human) until finally it became what it is today – arguably the dominant Domain. In the process, the old ‘natural philosophy’ faded away, replaced by a triumphant experimental philosophy or instrumental experimental science

6. In this regard, Michael Polanyi asserts that the university is the ‘natural’ home of the natural sciences (M. Polanyi 1960-61, 406). He argues that the source of new knowledge in other Domains is primarily outside the university in the ‘real’ world. This he considers appropriate because the natural sciences concern the objective unchanging laws of nature while other Domains are subject to the artificial laws and exigencies of the human condition. I will not, at this time, however, venture further into the changing structure and mandate of the university. Rather I will now re-focus on the epistemological dimension of knowledge.

10.1 Domains

1. The word ‘domain’ means “a sphere of thought or action; field, province, scope of a department of knowledge, etc.” (OED, *domain*, n, 4a). A Domain has two characteristics. First, as a province, it is hierarchically subject to the twin powers of Science by Design. Their influence, however, fluctuate over time, *e.g.*, over functional time between periods of normal and revolutionary science (Kuhn 1996) and over chronological time as in the shifting balance between Church and State in Western history. They also vary between the disciplines, sub-disciplines and specialities that make up a knowledge Domain.

2. Second, each Domain “as a sphere of thought or action” has a specific PSI, *i.e.*, configuration of Reason, Revelation, Sentiment and Sensation, accepted as methodologically appropriate for the acquisition of knowledge. This externalizes the dominance and subordination of faculties of analytic psychology demonstrated in the last chapter. It is also analogous to the configuration of a personal computer where usually there is a primary dominant/subordinate pair and a secondary dominant/subordinate pair of drives. The primary configuration will, for my purposes, serve to differentiate Domains, *i.e.*, using their PSI configuration.

3. In a process I call ‘pragmatic epistemology’, the Nation State has created, above the university, specialized funding agencies to foster and promote distinct knowledge streams. These now form part of the national innovation system even though many pre-date the NIS concept by two or three generations (OECD 1997).

4. In Canada, relevant agencies include the Natural Sciences & Engineering Research Council (NSERC), the Social Sciences & Humanities Research Council (SSHRC) and the Canada Council for the Arts (CC). In other English-speaking countries, the pattern is a variation on this theme. In the United States, there is a National Science Foundation embracing the natural & engineering sciences and the social sciences; a National Endowment for the Humanities; and a National Endowment for the Arts. In the United Kingdom there are, in effect, separate councils for each of the natural sciences, the engineering sciences, the social sciences, the humanities and the arts.

5. Such grant-giving councils are economic agents that direct public monies towards development of new knowledge – both for its own sake as well as for its contribution to the economy. In this sense they are *political economic* institutions. Which companies or troupes, programs, projects or individuals to support is generally decided by peer evaluation including grants made by individual officers who act, in effect, as one-person juries (Chartrand 1987a). Councils tend to reflect the political communities of interest active within each Domain. This grant-giving system parallels the practice of peer review of disciplinary journal articles. For my purposes, I identify three contemporary Domains:

- The Natural & Engineering Sciences (NES);
- The Humanities & Social Sciences (HSS); and,
- The Arts.

6. In the sixth century before the Common Era, the Chinese sage Sun Tzu suggested in his classic *The Art of War* that a battle may be won before it is fought through a clear understanding of the terrain (Sawyer 1994). The terrain of a knowledge-based economy is dominated by these three glacier-clad mountains. Each rises up above the lowlands and valleys of the economy. Each has its own historical and institutional foundation; each reaches to a summit of excellence - individual and institutional. In the NES and HSS, the traditional institutional peak is the university. In the Arts, it is the fine arts academy, museum, music conservatory or production company.

7. It is in these artistic, cultural and scientific ‘ivory-towers’ that most new knowledge is created, collected, compiled, conserved and/or coalesced into a nation’s knowledge base. From

their icy peaks rivers and streams of knowledge flow down winding circuitous paths or through channels chiseled deep into the historical bedrock of a Nation-State. In the valleys and lowlands their waters merge, mingle and mix to irrigate all sectors of a nation's economy.

8. Beyond the pragmatics of contemporary institutional structures, this trio is consonant with traditional pedagogy and epistemology. With respect to pedagogy, the NES corresponds to the natural philosophy of the medieval university; the HSS to moral philosophy; and, the Arts correspond to metaphysics and theology. In effect, theology, the institutional homeland of Revelation, the controlling faculty of Western knowledge for centuries, has been reduced to a Sentiment within the university, *i.e.*, a human value studied under the Humanities. Art, meanwhile, has donned the cloak of intuition and the associated god-like *ex nihilo* powers of creativity.

9. With respect to epistemology, since at least the time of Galileo a traditional distinction has also been made between primary, secondary and tertiary elements of knowledge, or experience. Primary knowledge concerns facts or quantities such as size and extension in space, number, weight or mass, motion and time. These elements of knowledge are regarded as belonging to the 'real' or physical world. They are accessible to observation, experiment and measurement. This is the domain of the NES.

10. Secondary knowledge, or qualities, pertains to sensations such as colour, taste, smell and form as well as larger concatenations of these qualities. Qualities are held to exist only in the mind of the observer, *i.e.* they are produced by the perceiving mind out of physical experience; they do not exist in the objective world. Accordingly, even if qualities are real, they are not directly accessible to the scientific method (Sloane 1991). This is the domain of the Arts.

12. Tertiary knowledge, or values, are not perceivable from the outside world but are rather innate ideas, divinely implanted or invented by the subjective observer (Griffin 1991). Being purely subjective, values (or morals) are not directly accessible to the scientific method. This is the domain of the HSS. In what follows, I will outline the natural history of each domain and demonstrate their PSI configuration of faculties.

10.1.1 Natural & Engineering Sciences

1. There are three primary natural science disciplines – biology, chemistry and physics. Each breaks out into an ever widening range of sub-disciplines and cross-disciplines, *e.g.*, biochemistry. In each there are distinct engineering specialties, *e.g.*, chemical, genetic, mechanical and, electrical engineering. It is from these that, today, most physical technology

flows. Price has argued that the relationship between science and technology is that of the research-front of one being related to the previous generation or archive of the other. Thus science operates with the previous generation of technology while technology operates with the previous generation of scientific knowledge (Price 1965, 568).

2. Arguably, the success of the NES in generating new knowledge can be attributed to three factors. First is the *Pythagorean Effect*, i.e., exploitation of the cognate relationship between mathematics and the world of matter and energy. Second is the *Instrumentation Effect*, i.e., scientific instruments generate evidence not requiring intermediation by a human subject and providing readings at, above and below the threshold of native human sensibilities. In effect, this lends metaphysical legitimacy to the NES. Scientific instruments, as previously noted, realize the Platonic “belief in a realm of entities, access to which requires mental powers that transcend sense perception” (Fuller 2000, 69). Furthermore, the language of scientific sensors realizes another ancient Greek ideal, that of Pythagoras, by reporting nature by the numbers. Third is the *Puzzle-Solving Effect* of ‘normal science’ (Kuhn 1996) which permits vertically deep insight into increasingly narrow questions, i.e., depth at the cost of breadth of vision.

3. Knowledge in the Natural & Engineering Sciences is fact-based and subject to objective, value-free testing in which replicability of results is the test. It is concerned with objective truth, understanding and manipulation of the physical world. It exhibits decreasing tolerance through time for difference and error as old knowledge is progressively and reductively displaced by the new, i.e., NES knowledge progresses vertically up the ladder of time.

4. Expressed in terms of analytic psychology, the NES assigns dominance to Reason while Sensation and Revelation (intuition) are subordinate and Sentiment suppressed. Using the computer drive metaphor, the primary dominant is Reason and the primary subordinate is Sensation. The secondary dominant is Revelation or intuition while the secondary and repressed subordinate is Sentiment. It is the primary configuration of Reason/Sensation that characterizes the NES – measurable quantity.

5. In the NES, Sensation is thus in the service of Reason embodied in scientific instrumentation that completely isolates or distances the observer from the observed and from the passions of flesh and spirit. This contrasts with the Arts in which Sensation is dominant subordinating Sentiment to produce sensual or aesthetic effects on a flesh and blood audience. The contrast is one of the extroversion/introversion of Sensation. In the NES, Sensation is directed outward into the physical world by Reason. In the Arts, Sensation is directed inward

into the psychic world by Sentiment. The result James Hillman calls *The Thoughts of the Heart* (Hillman 1981).

6. When applied for utilitarian purposes, NES knowledge generates physical technology, *i.e.*, the ability to manipulate matter and energy to satisfy human want, needs and desires. The impact of the experimental method in the NES has, as previously noted, been impressive in evolutionary terms. In twenty-five generations we have literally enframed our planet enabling ourselves of its bounties, making them ready at hand to serve our purpose, from the deepest oceans to the outer reaches of the solar system.

10.1.2 Humanities & Social Sciences

1. Much has been and more will be said about the Scientific Revolution and its implications for a knowledge-based economy. One seldom hears, however, about the preceding 'Humanist' and subsequent 'Social Science' revolutions. Yet they happened and they too have significant implications. The Humanist Revolution of about 1400 C.E. pre-dates the Scientific Revolution by some two hundred years which, in turn, pre-dates the Social Science Revolution of roughly 1800 by about two hundred years. This sequence is not necessarily co-incidental. One revolution builds upon the foundations laid by its predecessor. The sequence may or may not continue with the year 2000 marking, perhaps, the dawn of the Genomics Revolution. We will know only with historic hindsight.

2. The Humanist Revolution was a revolution of the mind leading to our modern concept of the individual as the legal and ethical foundation of democratic society. But, as will be seen, like the subsequent Scientific and Industrial Revolutions, the Humanist Revolution happened despite the university, not because of it.

3. From an economics perspective the Humanist Revolution was the result of two factors: (i) a sudden decrease in the supply of labour, specifically of educated labour; and, (ii) growing demand for such labour by two competitors – Church and State.

4. After the first Crusade in 1095 C.E., Western Europe gradually stabilized over three hundred years into a highly structured feudal system of subordination. The last wave of 'barbarians', the Vikings, had been successfully assimilated into Christendom. Pressures eased from the Islamic south and east with Mongol hordes reaching the borders of Egypt. In the north-east, the same Mongols halted in and then withdrew from Hungary to southern Russia in 1241-2 where descendents of the Golden Horde live to this day, *i.e.*, the Crimea Tartars.

5. Except for dynastic disputes and those between the Papacy and the titular Western Holy Roman Emperor, Western Europe experienced a period of relative peace and prosperity known as the High Middle Ages. One was born, however, into a designated slot in a geographically-limited life from which there was no escape except the Church and death. The peasant was subordinate to the lord of the manor who, in turn, was subordinate to the Crown, who, in turn, was subordinate to God. Guilds, municipal, trading and other corporations received exclusive grants of privilege from the Crown in return for oaths of fealty and tribute. The first universities were created at this time and in this same manner. The English family names ‘Smith’ and ‘Cooper’ sum up this system – one was known by one’s trade or ‘mystery’ not bloodline *per se*: a Smith being a metal worker of some sort and a Cooper being a barrel maker. Social space as in traditional Japan was fully defined (Kahn 1970). Everyone knew their place. Status fraud was a crime. This caste system might have lasted much longer had not two historically coincidental developments shocked the system.

6. First was the rise of the secular state beginning in Italy where government took the form not only of monarchy but also of commune, republic and, of course, the Papal States. Humanists first appeared here marking the beginning of the Renaissance about 1400. Their predecessors were notaries and public officials of the many Italian city states including Rome, capital of the Holy Roman Catholic Church. One branch – accountants – introduced the double entry ledger that supported the commercial revolution in the West’s trade with the East. Another branch included the secretaries, speechwriters and diplomats of princes, popes and dukes as well as the republics or communes of Florence, Genoa and Venice. While some attended the new universities most were of common rather than noble birth.

7. Unlike northern Europe, the increasingly urban Italians looked out every day to see clear evidence that their fame and fortune was as nothing compared to the ancients. This led to a search of the past for examples of greatness to make comparisons with their patrons. Humanists produced “hymns to the gods and praise of famous men” as required by Plato (*The Republic*, Book X, 1952: 433-434). Fame was what patrons wanted and fame was what Humanists gave and, by association, they thereby received. This focus on fame distinguishes the Humanists of the 14th through 16th centuries from the natural scientists of the 17th who were concerned with contributing ‘knowledge-for-knowledge’s-sake’. This tradition, it has been argued, was established by late medieval ‘Mechanics’ who in journals dedicated their knowledge to the future growth and improvement of their craft, not to personal fame or fortune (Zilsel 1945).

8. Nonetheless the Humanists initiated serious epistemological investigations, some of which eventually entered the university, *e.g.*, philology or comparative linguistics that, in a

certain sense, was the first social science. While some Humanists attended university, they were not part of the university. Their natural environment was secular, not scholastic or religious. In effect, Humanist separated secular human life, especially politics, from religion, *e.g.*, Machiavelli (1469-1527).

9. The second shock to the system was the Black Death which ravaged Europe between 1347 and 1351, two generations before the Renaissance. Originating in China and Inner Asia, the plague was transmitted to Europe when a Kipchak army, besieging a Genoese trading post in the Crimea, catapulted plague-infested corpses into the town. The disease then spread to the Mediterranean ports and beyond (Encyclopedia Britannica, “Black Death”, 2003).

10. While mortality rates varied the monastic communities had the highest incidence of victims. The ranks of the Church were decimated, *e.g.*, the papal court at Avignon was reduced by one-fourth. In general, talent in all skilled trades became scarce; wages went up; and, the social status of the individual climbed gradually breaking the feudal chains of subordination giving birth to Capitalism. Fifty years later, unlike their medieval predecessors, Renaissance artist/humanist/engineer/scientists signed their works inaugurating the Western ‘cult of the genius’.

11. Humanism assumed that Man not God is the measure of all things. It declined as an epistemological force, however, for three reasons. First, it was identified with the Republic and when the political fortunes of Italy turned and French and German armies marched in, many Humanists found switching allegiances ethically difficult. Second, the vernacular – Italian, French, English and German - began to displace Latin but the Humanist’s bond with the glories of the past, Latin & Greek, proved difficult to break. Third, the Religious Wars of the 16th and 17th centuries beginning with Luther’s posting of his ‘Ninety-five Theses’ on the door of the Castle Church, Wittenberg on Oct. 31, 1517, put God back in the driver’s seat (Zilsel [1943] 2000; Cochrane 1976, Grudin 2003).

12. After the Scientific Revolution of the 17th century, the various Humanities were, in effect, absorbed by the university under Moral Philosophy. Today, the Humanities consist of a wide range of disciplines and sub-disciplines including: folklore, history, language & literature, linguistics, philosophy, religious studies and women’s studies (Chartrand 1980).

13. The modern social sciences arose out of two forces. First, the cult of the genius found expression in two individuals (excluding Marx and Freud) – Adam Smith (1723-1790) and Auguste Comte (1798-1857). Smith gave birth to economics out of moral philosophy. Writing in 1969, economist Kenneth Boulding could observe:

Adam Smith, who has strong claim to being both the Adam and the Smith of systematic economics, was a professor of moral philosophy and it was at that forge that economics was made. Even when I was a student, economics was still part of the moral sciences *tripos* at Cambridge University. It can claim to be a moral science, therefore, from its origin, if for no other reason. (Boulding 1969)

14. Comte gave birth to sociology by way of the natural sciences and in the process spawned Positivism. This, in turn, led to the Logical Positivists and the Vienna Circle of the twentieth century in the philosophy of science with epistemological consequences previously noted. For Comte, all sciences pass through a theological then metaphysical stage before entering a final positive or ‘mathematical’ stage. In the case of both Smith and Comte, it took until the last quarter of the 19th century before the university formally admitted economics and then sociology.

15. The second force leading to the emergence of the modern social sciences was the apparent success of the experimental instrumental sciences and the accelerating progress of technology. In Smith’s case this connection with the natural sciences is made in his early essay of about 1750: *Principles which lead and direct Philosophical Enquiries, illustrated by the History of Astronomy* (Thomson 1965, 213). This success also led the poet Coleridge to ask the philosopher of science, William Whewell, to rename natural philosophers. In 1833, he did so, coining the term ‘scientist’ (Snyder 2000).

16. There were, however, two contrary tendencies. The first was towards a unified single social science, *e.g.*, the sociology of Comte. The second was towards specialization. In the end, the second triumphed. Today the Social Sciences breakout into a very wide range of disciplines and sub-disciplines funded by the Social Sciences & Humanities Research Council of Canada including: administrative studies, archaeology, communications & journalism, criminology, demographics, economics, education, geography, industrial relations, information science, law, library science, political science, psycholinguistics, psychology, recreology & physical education, science policy, social work, sociology and urban & regional studies (Chartrand 1980).

17. The Humanities and the Social Sciences (HSS) seek knowledge about the human world. Whether the question is alienation, ethics, history, metaphysics, monopoly, political power or religion; the HSS are concerned with human values. Applying the psychological PSI, HSS assign dominance to Sentiment with Reason and Revelation subordinate and Sensation suppressed. The primary dominant is Sentiment, the primary subordinate Reason; the secondary dominant is Revelation, the secondary and suppressed subordinate, Sensation. It is the Primary relationship: Sentiment/Reason that characterizes the HSS - values. In both the Humanities &

Social Sciences, the pursuit of fame has given way as public motivation to contribution to knowledge.

18. Knowledge in the Humanities & Social Sciences (HSS) is value-based and subject to mixed value-free/normative testing in which historical context plays a critical role. It is synthetic in that it seeks reconciliation between objective and subjective truth. It exhibits shifting tolerances through time as old knowledge is recycled in a pedagogic spiral to which new knowledge is added. New knowledge therefore does not necessarily displace old knowledge and revisionism is common, *i.e.*, seeing old things in new ways as well as seeing new things in old ways.

19. The limited success of the HSS in generating new knowledge compared to the NES can be attributed to the absence of the Pythagorean, Instrumentation and Puzzle-Solving Effects noted above. First, while there may be some relationship, there is no apparent cognate relationship between mathematics and human behaviour. Second, HSS evidence – in its collection, compilation and analysis - is subject to intermediation by human subjects all along the evidence trail, limiting objectivity. Third, with the pedagogic exception of economics and its Standard Model, there is no generally accepted paradigm in any HSS discipline corresponding to ‘normal science’ that, according to Kuhn, is required for efficient puzzle-solving.

20. When applied, HSS knowledge generates organizational technology, *i.e.*, the ability to shape and mold human communities, enterprises, institutions and societies. This includes the entrepreneurial and managerial knowledge to combine capital, labour and technology into intermediate and final goods and services designed to satisfy human want, needs and desires. It more generally involves management and organization of the firm and Nation-State. It addresses questions about how to motivate workers and managers and how to marry them with financial capital as well as physical plant and equipment. The search for the best in organizational technology is sometimes called *In Search of Excellence* (Peters & Waterman 1982). In effect, the HSS provide the epistemological basis for governance.

21. The effects of organizational technology have been made explicit by Harvey Leibenstein’s discovery of ‘X-efficiency’, *i.e.*, consumption in the act of production. Leibenstein estimated that poor motivation of workers and managers costs the USA between 20 to 40% of gross national product (Leibenstein 1966, 1968, 1972, 1974, 1978, 1981, 1992). Similarly, it is generally recognized that the post-war success of the Japanese economy is attributable to superior organizational technology reflected in successful product innovation. By contrast, the historical inability of Canadian firms to successfully innovate is an example of poor

organizational technology (Economic Council 1985). The contribution of organizational technology to innovation has also been highlighted in the *World Competitiveness Report* (WEF/IMD 1992).

10.1.3 The Arts

1. The contemporary Arts consist of four primary disciplines and their sub-disciplines including: the literary, media, performing and visual arts. Each uses a distinct medium of expression: the written word; the recorded sound and/or image; the live stage; and, the visual image, respectively. Each discipline is composed of distinct sub-disciplines and schools. Each has a five stage production cycle: creation, production, distribution, consumption and conservation. And each takes on five distinct functional forms including: the amateur, applied, entertainment, fine and heritage arts (Chartrand April 2000).

2. The Arts have troubled western civilization from the beginning. Plato thus warned:

... we must remain firm in our conviction that hymns to the gods and praise of famous men are the only poetry which ought to be admitted into our State. For if you go beyond this and allow the honeyed muse to enter, either in epic or lyric verse, not law and the reason of mankind, which by common consent have ever been deemed best, but pleasure and pain will be the rulers in our State (Plato, Book X, 1952: 433-434).

3. It is ironic that it was not Art but Economics using Bentham's hedonic calculus that made pleasure and pain "the rulers of our State". Fear of Art was reinforced, not diminished, with Christianity. As one of three monotheist religions subscribing to the Mosaic Code (the others being Judaism and Islam), it explicitly prohibits worship of graven images. Among all three 'peoples of the book', so named in Islamic tradition, censorship of the image traces back to Moses and the Golden Calf. In the book (the meaning of the word - Bible), the Word is sacred but the image is at best profane; at worst, evil incarnate.

4. Metaphysic suppression was reinforced by social suppression: the Arts were for the Mechanical not the Liberal or 'free' classes of society. Other than 'hymns to the gods and praise of famous men' Aristotle tasked the Arts with imitation of Nature. After the fall of Rome a second task was added: imitating the Art of the Ancients. By both tests, the Arts of the Middle Ages failed.

5. Once the Renaissance imitators using perspective successfully approximated the original – natural or ancient - the Arts, specifically the visual arts, attained a significantly higher social status and the visual artist attained to celebrity. Thus in 1563 in Florence, under the personal influence of Vasari "the painters, sculptors and architects cut their previous connections with the

craftsmen's guilds and formed an Academy of Art (*Accademia del Disegno*), the first of its kind that served as a model for later similar institutions in Italy and other countries" (Kristeller 1951, 514). Recognition reflected, however, not just the result but also their method: geometric perspective. The artist/humanist/engineer/scientist was a geometer, a mathematician, an image captured in Dürer's 1514 engraving of *Melancholia* holding a protractor in his right hand with his chin supported by his left, a pose reminiscent of Rodin's much later statue *The Thinker* (1880). In a manner of speaking, that which allowed music to become a Liberal Art – its Pythagorean or mathematical connexion – was demonstrated in the Visual Arts.

6. Imitation continued to be the test until the late 18th century when the Fine or Beaux Arts coalesced and were rationalized through Baumgarten's philosophy of aesthetics - his new science of sensuous knowledge to balance logic as the science of intellectual knowledge (Kristeller 1952, 35). The word aesthetics itself derives from the Greek *aisthesis* - the activity of perception or sensation - which at root means "taking in" and "breathing in" - a "gasp", the primary aesthetic response (Hillman 1981). In effect, Baumgarten liberated the Arts from epistemological subordination to Church and State.

7. The successful imitation of Nature by the Arts combined with the success of the NES in revealing her secrets led to what is known as "*Querelle des Anciens et des Modernes*" or the battle of the Ancients and the Moderns. This marked the beginning of the 18th century Enlightenment and the end of the Renaissance and of traditional Humanism (Kristeller 1952, 19). Who are superior, the Ancients or the Moderns? The answer: the Moderns.

8. In the Arts, Sensation is the primary dominant that subordinates Sentiment while Intuition is the secondary dominant that subordinates Reason. The primary configuration Sensation/Sentiment characterizes artistic knowledge – quality. As noted above, the reversed position of Sensation - subordinate in the NES but dominant in the Arts - reflects extraversion versus introversion of Sensation. It also highlights four essential differences. First is the use of concepts versus precepts.

Whereas Art begins with desired effects and finds causes to create these effects and no others, Science starts with presumed causes and seeks effects to confirm or negate these causes. Art organizes ignorance by precepts while Science organizes knowledge by concepts (Nevitt 1978, 7).

9. A second difference is that new knowledge in the Arts does not necessarily displace the old. Rather King Tut still sells; Shakespeare is still performed; Bach is played more today than in the 17th century. New works are, however, being added all the time to the inherited repertoire if they pass the test of time. Thus artists, unlike scientists, face competition not just from their peers but also from their long-dead predecessors. At the same time, Egalitarian Realism or

poke-in-the-eye art including such icons as Mapplethorpe's homo erotica photographs and Andres Serrano's 'Piss Christ' found an audience during the Culture Wars of the 1980s and 1990s (Chartrand 1991). These correspond to the so-called 'Science Wars' of the same period (Fuller 2000).

10. Third, subject to Reason in the NES, Sensation is restricted to 'what is'. In the Arts, Sensation is dominant and an *avant garde* has existed since the mid-19th century that seeks change-for-change's-sake; it seeks novelty (Scitovsky 1976). The Arts embody the impulse toward the new and original, a self-conscious search for future forms and sensations to the point that the idea of change and novelty overshadows the dimensions of actual change. The artist no longer, as in the past, simply affirms a moral-philosophic tradition but rather searches for a new sensibility, a search which society actively encourages. It has been said that what is imagined in the mind of the artist today becomes the reality of tomorrow (Bell 1976, 33-35). It is in this sense that Revelation or intuition is the secondary dominant in the Arts.

11. Fourth, the role of Reason as dominant in the NES made entry into the university natural. In the case of the Arts, however, with the exception of music (due to its Pythagorean connection with mathematics) and literature (rhetoric and grammar), the Arts were not part of the ancient or medieval liberal arts curriculum (Cantor 1969: 66-67). The Arts were and still are considered 'crafts', *i.e.*, they involve experiential learning. This is epistemologically critical – knowing by doing. It was not until the Renaissance that the fine art academy was established as a formal center for visual art education, separate and distinct from the university (vom Busch 1985, 3). In theater and dance, there was no formal training in any English-speaking universities until the late 19th century and the fine arts were not fully admitted until after the Second World War (Robinson 1982, 178-179, 191-192). Once admitted, however, they had a dramatic effect on both the university and Anglosphere society in general (Toffler 1965). The traditional independent status of the music conservatory within the university is further evidence of the separate institutional pattern of learning pursued in the Arts.

12. Artistic knowledge is concerned with subjective truth; a search for a sense of *kosmos* or the right ordering of the multiple parts of the world. It is holistic in aesthetic contemplation or gestalt. Testing is purely personal and subjective: 'It works for me!' It tends towards increasing tolerance of differences, styles and tastes. It is value laden, not value free.

13. When applied, artistic knowledge generates aesthetic or design technology, *i.e.*, the ability to manipulate sensation through emotion or how we feel. The Arts provide the 'technology of the heart'. The arts industry includes all profit, nonprofit and public institutions

including incorporated and unincorporated enterprise as well as self-employed artists that: (a) use one or more of the arts as a primary factor of production, *e.g.* advertising, fashion, industrial and product design; (b) use one or more of the arts as a tied-good in consumption, *e.g.* home entertainment hardware, magazines and newspapers; and/or, (c) produce one or more of the arts as their final output, *i.e.* create, produce, distribute and/or conserve goods and services in the literary, media, performing, visual and/or heritage arts. Using this inclusive definition, I have elsewhere estimated that the American arts industry accounts for between 6% and 8.5% of Gross National Product, *i.e.* all goods and services consumed in the United States but not necessarily produced there ([Chartrand April 2000](#)).

14. Unlike physical and organizational technologies, however, design technology primarily affects the demand-side of the economic equation. In effect, design technology involves the use of the Arts to manipulate the aesthetic or emotional responses of consumers. In this sense, it is the technology of the human heart primarily appealing to emotion not to reason. It is thus more sensitive to culture, custom and tradition than physical technology. This fact, together with the injunction against the study of consumer taste – “De Gustibus Non Est Disputandum” (Stigler & Becker 1977) - explains why there has been little investigation by mainstream economics and why Art is simply ignored in the Standard Model.

15 Aesthetic design is fundamentally different from technical or functional design such as a more efficient automobile engine. It contributes ‘elegance’ defined as simple but effective or “the best looking thing that works” (Cwi 1985). If a consumer does not like the way a product looks, he or she may simply not try it. In effect, design technology involves marrying aesthetic to utilitarian value.

16. Beyond consumer goods, design technology plays a critical role in advertising and forms the foundation for the entertainment industry. It is generally forgotten that within the ecology of capitalist realism, advertising is the lubricant of the market economy. And advertising, to a great extent, is the application of the literary, media, performing and visual arts to sell goods and services. Actors, dancers, singers, musicians, graphic artists, copywriters, and editors are employed to sell everything from fruit to nuts; from cars to computers, from beer to toilet paper. Traditionally, mainstream economics has viewed advertising (with the exception of pure information) as unproductive because it manipulates consumer wants through non-rational techniques. Such manipulation reduces consumer sovereignty.

17. Entertainment art generates enjoyment, amusement and recreation. In the entertainment arts, America currently leads the world. Thus entertainment programming (film, recordings and

TV) has been reported as the second largest net export of the United States after defense products (*The Economist* March 11, 1989, 65-66). In a global knowledge-based economy, the Arts involve both economic and geo-political competitiveness.

18. If the relationship between science, technology and the university has been problematic in the Anglosphere, the relationship between Art and the economy has been even more so. Until 1814 the *Statute of Artificers* regulated training and employment of artisans in the craft guild tradition. In that year, responding to laissez-faire economic policies, the British Parliament abolished the statute. In short order, the guild system collapsed and the labor market became flooded with unskilled workers. By 1835 the competitiveness of top-end British products, particularly textiles, had declined to the point that the British Board of Trade appointed a select committee to investigate the problem and recommend remedies. The committee called for the direct application of art in manufacturing in order to maintain competitiveness with European rivals, especially Lyons in France and Munich in Germany. The result was the first school of design at South Kensington in 1836 (Savage, 1985, 94-97). It is interesting to note that the curriculum was designed to ensure lower-class craftsmen trained therein would never aspire to become artists who, by definition, were gentlemen (and later gentlewomen) of the Royal Academy of Art.

19. Similarly, in 1870, the Commonwealth of Massachusetts became the first American state to make art education a requirement in the public schools with passage of the *Drawing Act*. The Act originated through pressure by Boston manufacturers who argued that European students were trained in design and drawing and therefore American manufacturers suffered a competitive disadvantage (Freedman 1985, 21). Within two decades, the same argument served to introduce art education in Canadian schools (Chalmers 1985, 108). During this period, the most eminent of contemporary economists of the day, Alfred Lord Marshall, explicitly recognized the importance of art to economic life, even if he questioned the moral results of art education:

Education in art stands on a somewhat different footing from education in hard thinking: for while the latter nearly always strengthens the character, the former not infrequently fails to do this. Nevertheless the development of the artistic faculties of the people is in itself an aim of the very highest importance, and is becoming a chief factor of industrial efficiency... Increasingly wealth is enabling people to buy things of all kinds to suit the fancy, with but a secondary regard to their powers of wearing; so that in all kinds of clothing and furniture it is every day more true that it is the pattern which sells the things. (Marshall 1920, 177-178)

20. Since the Great Depression of the 1930s, however, the economic importance of design, and therefore the contribution of art to national income, has, in effect, been forgotten in the Anglosphere. Partially this reflects the dubious morality of the artist reflected in Marshall's words. It also reflects the pedagogic triumph of the Pestalozzian rationale for art education, namely creativity and expression, which displaced the economic rationale in the 1930s (Betenas 1985, 99-101).

21. It also reflects, however, a general shortsightedness on the part of contemporary economists and other social scientists concerning the nature and implications of the Industrial Revolution. The Industrial Revolution not only transformed production, it transformed the nature of consumption with mass advertising, the department store, fashion, and the mail order (McCracken 1988, 4). Lack of study means little existing empirical evidence about the impact of art on competitiveness. Nonetheless, its impact is, from time to time, still recognized:

There is, then, another aspect to culture, namely good taste, good design and creative innovation, that should enable smaller industrial economies to compete effectively in the world economy.... In this endeavor, higher quality implies an organic relationship between business and engineering, on the one hand, and design and craftsmanship, on the other.... High quality products, technologies, plants, homes, cities and locales require the presence of creative artists of all kinds. To increase the long-run supply of artists ... governments must support the artists and the arts. The long-term return from investment in artists and the arts is real and substantial. In the absence of strong public support of this sector, Canada will not reap these benefits. Governments at all levels should increase their contribution to their respective arts councils. (Royal Commission, 1985, 115-116)

10.2 The Practices

1. If Domains are concerned with the growth of knowledge then the Practices are concerned with its application in satisfying very specific and pressing human wants, needs and desires. For my purposes, a practice is the “carrying on or exercise of a profession ..., esp. of law, surgery, or medicine; the professional work or business of a lawyer or medical man” (OED, *practice*, 5). I extend this definition to include other traditional and contemporary professions such as accountant, architect and engineer.

2. In turn, a profession is a “vocation in which a professed knowledge of some department of learning or science is used in its application to the affairs of others” (OED, *profession*, III 6). Put another way, practices “link bodies of knowledge to forms of action” (Layton 1988, 92). I will, however, narrow this definition to exclude the now obsolete definition of profession as “the function or office of a professor in a university or college; ... public teaching by a professor” (OED, *profession*, IV 7).

3. Application of professed knowledge to satisfy the needs of others involves knowledge in action that accounts for theory, the client/patient relationship and ethics, *i.e.*, “the science of morals; the department of study concerned with the principles of human duty” (OED, *ethics*, II 2). Professional ethics, of course, are a socially conditioned and historically relative.

4. This distinct form of knowledge may be called ‘praxis’, a term with a colourful history of its own. It was coined by the alchemist, metaphysician and subsequent saint, Albert Magnus, about 1255 C.E. He derived it from a Greek noun of action meaning “doing, acting, action, practice” (OED, *praxis*, Epistemology). It was re-coined by Cieszkowski in 1838 to mean “the willed action by which a theory or philosophy... becomes a social actuality.” It was then adopted by Marx in 1844 for whom it explained “how knowledge could give power” not through thought like Hegel but through the will. In this sense, praxis approximates design in its emphasis on intent (OED, *praxis*, 1 c). It also reflects knowing by doing, not just by the senses or mind. Practice as experience is another facet of praxis as knowledge. More generally, praxis means the “practice or exercise of a technical subject or art, as distinct from the theory of it” (OED, *praxis*, 1a). For my purposes it will mean ‘knowledge in action’. In this regard, it is important to remember that knowledge can be used as a verb as well as a noun (OED, *knowledge*, v)

5. The Practices centre on the self-regulating professions such as accounting, architecture, dentistry, engineering (applied), law and medicine. Practices engage knowledge in real life situations while Domains involve knowledge creation or interpretation, *e.g.*, knowledge-for-knowledge-sake or art-for-art’s-sake. Praxis is not academic speculation. It is not knowledge as a noun but as a verb affecting the lives of real people. As in aesthetics and science, however, the Practices observe a professional distance from their subject but it is the very subjective human being. And unlike the atoms, cells and the physical structures of the NES, people can and do sue for ‘malpractice’. In fact, malpractice and product liability lawsuits are a hot button political issue in the United States due to their alleged negative effect on American competitiveness.

6. The Practices draw, merge, mingle and apply knowledge and methodologies beyond those internal to their experience from all three Domains in varying combinations, *e.g.*, the use of actors by medical schools to prepare future physicians to face the emotional realities of patients. Another example is the Art of Dentistry. Unlike academic disciplines, *e.g.*, economics, final certification or ‘licensing’ is not granted by the university but rather by an independent professional society, *e.g.*, a College of Physicians and Surgeons. This partially reflects the fact that praxis cannot be fully codified, *i.e.*, written down. Put another way, there is a gap between graduation and professionalism that must be filled before being licensed to practice

independently. This gap is reflected in the requirement, in all Practices, of some kind of compulsory apprenticeship, articling or internship.

7. In many ways, the Practices are descendents of medieval guild mysteries operating in the Mechanical Arts. More so than academic disciplines, the Practices control entry and exit, set rates, supervise initiates and regulate practice. In the case of medicine and law they were also the first practical subjects to be admitted to the university. Some Practices are also associated with grant-giving or funding agencies such as the Canadian Institutes for Health Research (formerly the Medical Research Council of Canada) and the National Institutes of Health in the United States.

8. Guilds originally received their charters from the Crown granting them monopoly rights in return for fealty and sometimes tribute. Today the Practices are regulated by the State, but as with business law ([Commons 1924](#)), most traditional customs and privileges of the Practices are effectively enshrined, preserved and protected by legislation under Common Law.

9. As private institutions serving the public purpose – including health, education and welfare as well as wealth and legal rights – the Practices have seldom been acknowledged as critical players in the competitiveness of nations in a global knowledge-based economy. How they should be regulated and held accountable is, however, an important question for public policy in general and for development of an effective national innovation system in particular. As demonstrated by Birkenshaw, Harden and Lewis (1990) in their review of *Government by Moonlight: The Hybrid Parts of the State* in the U.K., USA, France, Germany and Austria, there are different ways in which this may be done. More will be said below.

10. Before ending this chapter with a reconciliation of Domains and Practices, I wish to profile one of the most important and relatively recent additions to the Practices – Engineering. This will highlight the different types of knowledge involved in the Practices and differences in national treatment. Engineering, as a formal practice, did not emerge in the English-speaking world until the mid-19th century. It is the offspring of an epistemological *ménage à trois* of craft technology, mathematics and the natural sciences. It continued the empirical and experimental traditions of the crafts including architecture but replaced rule of thumb mathematics first by statistics (Layton 1976, 692) and, much later, by calculus. Thus, “American engineers were still debating in the 1920s whether students needed to learn calculus” (Kranakis 1989, 18). It also absorbed the findings of the natural experimental sciences.

11. This order of epistemic integration differs from continental Europe where in France, for example, scientific engineering emerged a hundred years earlier with a requirement for training

in the calculus at specially created academic institutes such as the Ecole des Ponts et Chaussées (1747) and the Ecole Polytechnique (1794). As a Practice, however, it was restricted to public engineering of armaments, canals, fortifications, roads, etc., and did not extend to private industrial production (Finch 1952). In France too, rules of thumb, craft laws and design principles rather than mathematics continued to dominate industrial production.

12. Engineering in the Anglosphere (Bennett 2000) remains much more of a ‘self-regulating profession’ than an academic discipline as in Europe. Furthermore, emphasis has historically been on industrial research, particularly in the United States, in contrast to theoretical studies in France where an industrial research tradition did not develop until well into the twentieth century (Kranakis 1989, 7)

10.3 Reconciliation

1. Excepting the Humanities & Social Sciences, both the NES and the Arts exhibit significant praxis. In the case of the experimental instrumental sciences this includes designing and building instruments as well as their operation. In the Arts, praxis creates the illusion of verisimilitude. This facilitates what the poet Samuel Coleridge called the temporary or willing ‘suspension of disbelief’ required of an audience. And like the Practices artistic knowledge is intended to affect natural persons in their daily lives. Professional ethics in the Arts, however, are radically different than in the Practices, *e.g.*, to deliberately shock and disturb a client is not normally accepted in the Practices; it is in the Arts, *e.g.*, *The Shock of the New* (Hughes 1981).

2. There are also borderline cases such as geography and psychology sometimes function like Practices. In the case of psychology, for example, professional practice outside the university is common. Applied psychologists work in business, education and government conducting employee and student testing and placement, *e.g.*, *The Myers-Briggs Type Indicator*®. Furthermore, psychiatry clearly crosses the border into medical practice. In the *Occupational Classification Manual for the Canadian Census of 1971* ten different occupations in psychology were identified as being applicable to any industry (DBS 1971, 63). Similarly, practicing geographers can be found outside the university working in urban and transportation planning departments of governments as well as environmental departments and agencies of both business and government. Furthermore, geography’s link with geology can also cross over the border into the NES.

3. When it comes to economics the border lines become even more obscure. Economists are employed by for-profit and non-profit enterprise as well as government. In the *Occupational*

Classification Manual for the Canadian Census of 1971 thirty-two different occupations in economics were identified as being applicable to any industry (DBS 1971, 63).

4. Thus the borderline between Domain and Practice is more an osmotic membrane than an impenetrable barrier. Knowledge from Domains seeps into the Practices and praxis seeps into Domains. This is consonant with the interpretation of knowledge as a biological rather than mechanical phenomenon. With respects to Domains and Practices, this mutability can be expressed in the form of two related Qubits of knowledge – the EPI and the PED.

10.4 Qubit EPI

1. The EPI is a four-fold measure of knowing *via* the Natural & Engineering Sciences (NES), the Humanities & Social Sciences (HSS), the Arts (literary, media, performing and visual) and the Practices. The EPI can be expressed as some function of NES, HSS, Arts and the Practices. In brief, the NES generate knowledge about the physical world of matter and energy; the HSS generate knowledge about being human - individually and collectively; the Arts generate knowledge about human emotion; and, the Practices apply knowledge from the first three to answer practical and pressing problems of daily human life. The three Domains – at their professional peaks - generate new knowledge as ‘knowledge-for-knowledge-sake’ or ‘art-for-art’s-sake’ while the Practices apply knowledge to solve practical human problems.

10.5 Pedagogic PED

1. While the EPI provides a qubitic measure of epistemological knowledge, another Qubit can be identified at the pedagogic level. Knowledge can thus be classified according to its domain/practice, discipline, sub-discipline and specialty. This quartet constitutes the Qubit PED.

2. In the previous two chapters I individuated the content of knowledge as an etymological WIT (by the senses, mind, doing, experience) and psychological PSI (Reason, Revelation, Sentiment, Sensation). In this chapter I socialized the content of knowledge as an epistemological EPI (NES, HSS, Arts, Practices) and pedagogic PED (domain/practice, discipline, sub-discipline, speciality). In the next chapter I will legalize knowledge as property that can be bought and sold and yet eventually enters an immense and ever growing public domain - available without charge to any and all – which constitutes our social genetic inheritance and the legal foundation of our democratic freedoms.

11.0 LAW

1. If, as Michael Polanyi (1962a) believed, all knowledge is ultimately personal & tacit then the question arises: how does knowledge become legal property that can be bought and sold? Property means ownership together with associated rights of access, or, in this case, ‘rights to know’. This question is pertinent for at least three reasons.

2. First, given the public goods nature of knowledge in the Standard Model of economics, *i.e.*, non-rivalrous and non-excludable, there is no ‘natural’ mechanism permitting formation of markets. How can a producer make a profit if users cannot be denied access and such access does not reduce the availability of the good? As will be seen, without government intervention there can, in fact, be no market for knowledge. This, of course, contradicts one of the major premises of the Standard Model – no government.

3. Second, given the public goods nature of knowledge and the necessity of government intervention for markets to exist, the knowledge-based economy should exhibit characteristics not only of Market but also of Marxist or collectivist economics. As will be seen, a critical component of the knowledge-based economy is, in fact, a public domain from which anyone can freely draw, each according to one’s need. And it is this public domain that makes up the bulk of the national knowledge-base and provides the critical foundation for popular democracy.

4. Third, given the public goods nature of knowledge and the necessity for government intervention for markets to exist, knowledge nonetheless remains ultimately personal & tacit. This contradiction is resolved in market economies through ‘the myth of the creator’ to which I now turn attention.

11.1 The Myth of the Creator

1. In pre-literate societies, knowledge was transmitted orally through the mnemonics of ritual and chant reinforced by religious practice and taboo. Some knowledge was shared by all; some was shared in secret only with initiates (Eliade 1954). The association of rhythmic or repetitively patterned utterances with supernatural knowledge endures well into historical times. For example, among the early Arabic peoples, the word for poet was *sha’ir*, “the knower”, a person endowed with knowledge by the spirits (Jaynes 1978). Innovation, *i.e.*, application of new knowledge, depends upon the initial insight of a creator *plus* his or her ability to maintain its

mnemonic integrity through time, *e.g.*, as incantation or epic poem. Cause and effect are indistinguishable. It is through unchanging re-enactment of ritual that desired results are achieved. Science and art are one. How to make something and the thing made are mystically married. Process and product are identical. To name a thing is to magically control a thing.

2. In such societies, awe and mystery surround the created object into which the creator projects his or her spirit and soul. In Japan (a First World country retaining many ancient animistic sensibilities), a sword, being a product of mental work, is regarded not merely as a material object, but as being imbued with the author's living spirit. The result can arguably be seen in contemporary Japanese industrial craftsmanship. Furthermore, objects of worship are not limited to visible and concrete things. Even a word can have a spirit. (Koisumi 1977, 12). One cannot buy or sell such knowledge; only the material shell containing it. Knowledge, in effect, is the soul-stuff of a creator.

3. In the ancient Western and contemporary Islamic world, at least until recently (Habib 1998), knowledge was kept secret or, when made public, its paternity was protected by moral rather than legal rights (Chartrand April 2000). Ownership, in an economic sense, did not exist *per se*. Punishment for falsely claiming paternity, or what today we call copyright or patent infringement, took the form of defamation of the infringer and casting shame on his or her family and tribe.

4. After the fall of Rome, knowledge in the West became the preserve of the Christian Church. In secluded, distantly separated monasteries surviving written works of the Ancient World were lovingly copied and preserved. They provided the epistemological gold standard for secular knowledge in the so-called 'Dark Ages' while the Bible shed all the light thought necessary on God's purpose. Those who dared draw knowledge from the well of ancient nature lore, what today among Fourth World people's is called 'traditional ecological knowledge' or TEK, were branded witches and warlocks while those who experimented with nature were branded alchemists and magicians. Both were subjected to the same penalty: Burn the body, save the Soul! Old 'approved' knowledge was revered; new knowledge was generally suppressed making ownership literally a metaphysical question.

5. With the arrival of the 'Renaissance Man' in the 15th century, the artist/engineer/humanist/scientist, there began a distinct Western European 'Cult of the Genius' (Zilsel 1918; Kristeller 1954, 510; Woodmansee 1984). Genius, no matter its social origin, demonstrates god-like powers creating *ex nihilo* (Nahm 1947). Such new knowledge changes the way people see, hear and understand the world and themselves. Fed by Christian belief in

the equality of souls and theological rejection of slavery, this marked the first eruption of the individual Person out of feudal subordination by birth. Ownership of ‘new’ knowledge, as will be demonstrated, began to evolve into marketable and legally enforceable intellectual property rights. Ownership became not just a question of metaphysics and morality but also of money and wealth.

6. In the 17th century the experimental philosopher and in the 18th, the author joined this pantheon of Western genius (Woodmansee 1984). As previously noted, increasing amounts of new knowledge flowing from all domains initiated the “*Querelle des Anciens et des Modernes*”, *i.e.*, the battle of the Ancients and the Moderns marking the beginning of the 18th century European Enlightenment (Kristeller 1952, 19). Who are superior, the Ancients or the Moderns? Again, the answer: the Moderns.

7. By the end of the 18th century Republican Revolutions shattered feudal subordination declaring all men equal. In the 19th, the inventive genius of Watt was followed by Bell, Edison, Marconi, Morris and others who transformed the life ways of humanity. And, about the same time as the first telephone call in 1876, the troubled and tortured artist starving in his garret became the spear point of an *avant garde* transforming the way humanity sees and hears its inner and outer worlds (Bell 1976). Finally, in the 20th century, natural & engineering scientists donned the cape of genius as the atomic bomb and nuclear energy, followed by computers, genomics and space travel, caught the popular imagination with a fuzzy haired Einstein as its poster boy.

8. Out of this traditional Cult of the Genius emerged what I call the Myth of the Creator (Chartrand Fall 2000) eloquently expressed by Zechariah Chafee.

... intellectual property is, after all, the only absolute possession in the world... The man who brings out of nothingness some child of his thought has rights therein which cannot belong to any other sort of property. (Chaffee 1945)

Creation of new knowledge in all domains - the natural & engineering sciences, the humanities & social sciences and the Arts – became a public good to be fostered and encouraged so that all humanity might benefit from the creativity of genius. The question is, of course, how should genius be fostered and encouraged?

9. Like most myths this one contains some elements of truth. Thus, under the European Civil Code tradition, the myth is reflected in the moral rights of creators that are “inalienable, unattachable, imprescriptible and unrenounceable” (Article 11, Decision 351, Andean

Community, 1993). Such rights echo back to ancient animism and are deemed self-evident under the principles of ‘natural law’ (Taylor 1929, 1930), the supposed root of the Civil Code.

11. Unlike the Civil Code, however, the Anglo-American Common Law, and its associated intellectual property rights (henceforth, IPRs), is rooted in precedent rather than principle. The result is that:

the complex body of law, judicial interpretation, and administrative practice that one has to grapple with in the area of intellectual property rights has not been created by any rational, consistent, social welfare-maximizing public agency.” (David 1992)

11. The resulting patchwork complexity is arguably one reason why there has been limited empirical economic analysis of IPRs (Besen & Raskind 1991, 4). In economic theory, however, IPRs are justified by market failure, *i.e.*, when market price does not reflect all benefits being captured by the consumer and all costs being paid by the producer, *e.g.*, when market price does not include pollution costs. These are generally known as external costs and benefits, *i.e.*, external to market price. IPRs, in this view, are created by the State as a protection of, and incentive to, the production of new knowledge which otherwise could be used freely by others (the so-called free-rider problem). In return, the State expects creators to make new knowledge available and that a market will be created in which such knowledge can be bought and sold. But while the State wishes to encourage creativity, it does not want to foster harmful market power. Accordingly, it builds in limitations to the rights granted to creators. Such limitations embrace both time and space. They are granted, assuming full disclosure of the new knowledge:

- only for a fixed period of time, *i.e.*, either a specified number of years and/or the life of the creator plus a fixed number of years; and,
- only for the fixation of new or original knowledge in material form, *i.e.*, it is not ideas but rather their fixation in material form (a matrix) that receives protection.

12. Eventually, however, all intellectual property (all knowledge) enters the public domain where it may be used by anyone without charge or limitation. Even while IPRs are in force, however, there are exceptions such as ‘fair use’ or ‘fair dealing’ under copyright. Similarly, national statutes and international conventions permit certain types of research using patented products and processes. And, governments retain authority to waive all IPRs in “situations of national emergency or other circumstances of extreme urgency” (WTO/TRIPS 1994, Article 31b), *e.g.*, following the anthrax terrorist attacks in 2001 the U.S. government threatened to revoke Bayer’s pharmaceutical patent on the drug Cipro (BBC News October 24, 2001).

13. Nonetheless, the foundation stone of contemporary IPRs is that an idea, *a.k.a.* knowledge, is not protected, only its expression fixed in material form or a matrix. I will first examine the nature of the matrix and its relationship to IPRs. I will then consider the major categories of IPRs – copyrights & trademarks, patents & industrial designs, know-how & trade secrets. This will be followed by an examination of the public domain where the vast bulk of human knowledge resides. In effect, IPRs define our legal, and therefore our economic rights to know.

11.2 The Matrix

1. Intellectual property rights do not protect ideas but rather their expression fixed in a tangible material form called a ‘matrix’. A matrix is a “supporting or enclosing structure” (OED *matrix*, n I). A tangible material form is something that, traditionally, can be seen, touched or otherwise perceived by a human being and, furthermore, has some permanence. Finally, any expression fixed in a matrix must be original to receive protection by the State. Four questions arise. Why are ideas not protected? What constitutes a matrix? What does perception of a matrix mean? And, finally, what is the function of a matrix relative to knowledge embedded or fixed therein.

2. Justice Yates, in his dissenting opinion in the 1769 case of *Millar v. Taylor*, laid out the legal argument why ideas are not protected. He argued, drawing on the *Institutes of Justinian* (one of the sources of the Civil Code), that ideas are not the object of property rights because they are like wild animals or *ferae naturae* that once set free belong to no one and everyone at the same time, *i.e.*, they are in the public domain. It is only their specific expression fixed in material form – commonly known as a work – that qualifies for protection (Sedgwick 1879).

3. What constitutes a matrix is problematic. Examples drawn from the recent history of copyright in Canada and patents in the United States demonstrate. Under Canadian copyright until 1988, recorded extemporaneous music, *i.e.*, music improvised and simultaneously recorded, did not qualify for protection because it was not “reduced to writing or otherwise graphically produced or reproduced” (Keyes & Brunet 1977, 40). The recording itself did not qualify as a matrix. Similarly, until 1988, computer programs did not qualify because they could not be ‘read’ by a human being (Keyes & Brunet 1977, 40). Today, of course, the Microsoft business empire, among others, is rooted in software copyright.

4. U.S. patent examples also demonstrate the role of case law in developing IPRs in the Anglo-American tradition. Unlike Civil Code principles which tend to be stable, case law is

determined by judges whose reasoning influences subsequent interpretations of the law by precedent. In the case of genetic patents, the U.S. Patent Office denied patents to living material including genes until 1980. At that time the Supreme Court in [Diamond v Chakrabarty](#) reinterpreted existing law, *i.e.*, there was no change in the law itself. The case involved a patent for a genetically engineered microorganism that breaks down crude oil. The Court observed that Congress had the power to limit such patents but by failing to legislate specifically about genetic patents it had, in effect, allowed gene patenting. The Court's rationale was based on the term 'manufacture' in Section 101 of the U.S. Patent Act: "the production of articles for use from raw materials prepared by giving to these materials new forms, qualities, properties, or combinations whether by hand labor or by machinery." Genes, the Court concluded, were material, *i.e.*, they had tangible material form, even though invisible to the naked eye.

5. With respect to software patents, the Patent Office resisted patentability because computer programs were considered mathematical algorithms, not processes or machines. In its 1981 decision in [Diamond v. Diehr](#), the Supreme Court ordered the Office to grant a patent even though computer software was involved. The Court found the program was not just a mathematical algorithm but rather a process, specifically for molding rubber. The Patent Office continued to be troubled in distinguishing a computer program from an algorithm. In the 1990s the Federal Circuit Court tried to clarify the question by requiring that an invention be examined as a whole and finding that an invention using a computer to manipulate numbers representing concrete or real world phenomenon is a process relating to tangible material forms and is patentable. In 1996 the Patent Office adopted its [Final Computer Related Examination Guidelines](#) making a computer-related invention patentable if the program is used in connection with a specific machine or product (Tysver 1998).

6. As demonstrated, a matrix originally needed to be perceptible by a human being, particularly by sight. The law, being inherently conservative, traditionally concluded that if the matrix was not perceptible then it was not possible to assess other requirements for protection, *e.g.*, originality, non-obviousness, usefulness, *etc.* For example, ephemeral displays on computer screens, prior to 1988, received no protection in Canada. An electron might be a part of the physical world but if a lawyer could not see, touch or otherwise perceive it then it had no legal standing as a matrix (Keyes & Brunet 1977, 129).

7. In effect, over time, the use of instrumentation to extend the reach and grasp of the human senses has been accepted by the Courts. The implication is that there is no longer any microscopic (or macroscopic) legal limit to intellectual property being fixed in material form, only a technical one.

8. Essentially a matrix has one of three functions – utilitarian, non-utilitarian or personal. As will be demonstrated, a utilitarian matrix corresponds to a Tool and is protected by patents & industrial designs; a non-utilitarian matrix corresponds to a Code and is protected by copyright & trademarks while a personal matrix corresponds to a Person and is protected by know-how & trade secrets.

11.3 Rights to Know

1. While the matrix can be used to order intellectual property rights into generic categories – utilitarian, non-utilitarian and personal - the nature, scope and composition of each IPR is different. Each provides the legal foundation for a distinctive industrial organization based on the commercial exploitation of new knowledge. Furthermore, each consists of a distinct and differing bundle of rights defining what forms of knowledge can be bought and sold, where it may be marketed, under what terms and conditions, and for how long such rights are enforceable before new knowledge enters the public domain.

2. The law, however, is a cultural artifact, *i.e.*, it varies in principle and practice between countries and cultures. IPRs therefore vary significantly between and even within neighborhoods of the global village (Chartrand 1995). Thus among First World countries two distinct traditions exist – Anglo-American or Anglosphere Common Law and European Civil Code. Yet even within these traditions there are significant variations, *e.g.*, between American, British and Canadian IPRs. Furthermore, unlike other internationally traded goods and services subject to harmonization under the WTO, IPRs are subject to the milder constraint of ‘national treatment’. This means a Nation-State must extend to foreigners the same rights it grants its own citizens but such rights need not be, and generally are not, the same, nation to nation.

3. This degree of freedom is a lever increasingly being used to enhance the competitiveness of nations. Nation-States are actively engaged in reform and revision of their IPR regimes. Each strives, formally and informally, to develop an optimal legal framework for the generation of new knowledge and its subsequent commercial exploitation - subject to the constraints of its history, custom and tradition. This evolving legal structure is, in turn, part of a broader national innovation system (OECD 1997).

4. In what follows I will summarize the Anglo-American histories of the six primary IPRs. These are presented in groups of two based on a common matrix – designs & patents (utilitarian), copyrights & trademarks (non-utilitarian), and know-how & trade secrets

(personal). Only passing reference is made to Civil Code practice. An additional class of IPRs is also discussed, *sui generis* or one-of-a-kind rights.

5. There are, however, three general characteristics of the Anglosphere tradition that colours these histories. The first concerns the origins of the Common Law of business. The second involves the relationship of natural and legal persons. The third involves the evolving definition of property, *i.e.*, what can be bought and sold.

6. First, after the *Statute of Monopolies* of 1624 development of the Common Law was a process whereby the courts converted the customary bargains and business practices of guilds and corporations into a common law of property and liberty ([Commons 1924](#): 229). However, while “the monopoly, the closed shop, and the private jurisdiction were gone ... the economics and ethics remained” ([Commons 1924](#): 230).

7. Second, a natural person is a living human being; a legal person is a body corporate. The vast bulk of productive assets are owned by fictitious legal persons such as corporations, companies, sociétés, Gesellschaften. Such persons are birthed under incorporation statutes that allow them to engage in a wide variety of profit making and charitable activities. By extension, in the futuristic world of William Gibson, computer-based artificial intelligence qualifies for Swiss citizenship (Gibson 1984). In the Anglosphere tradition, however, legal and natural persons enjoy the same rights; under the Civil Code they enjoy different rights. It is with respect to knowledge that this difference is most apparent. Thus Civil Code moral rights of creators are justified because their work bears the “imprint of personality” that a body corporate simply does not possess (Geller 1994). This imprint of personality has fueled ongoing controversy between the United States and the European Union, especially France, over extending to American media corporations doing business in Europe, rights restricted under Civil Code to natural persons.

8. Third, there is an important historical connexion between the evolution of intellectual property rights and the definition of property itself. This involves movement away from defining property as ‘things’ – moveable or immovable – towards property as the intangible expectation of profit.

9. Two years before publication of the *Wealth of Nations* perhaps the most momentous legal decision in the history of knowledge and the modern definition of property was reached in 1774 by the Law Lords of England in the case of *Donaldson v. Beckett*. The question was: Does an author have a natural and perpetual copyright? The answer was no ([Chartrand Fall 2000](#)). Beyond its implications for copyright, this decision arguably contributed to the modern definition of property in what J.R. Common’s calls:

The transition from concepts of physical things to concepts of business assets, [that] could not be fully completed until the idea of ownership was shifted from the holding of physical things to the expectations of profit from the transactions of business. ([Commons 1924](#), 275)

This shift from tangible to intangible property gave birth to many new and valuable business rights such as ‘good will’. This trend may be approaching an apogee with the emergence of the knowledge-based economy.

11.3.1 Copyrights & Trademarks

1. Copyrights and trademarks use a non-utilitarian matrix to encode knowledge in a material form called a ‘communications medium’. Media takes many forms including paper hardcopy and electronic softcopy. In all cases, however, it is intended to be read or decoded by a natural person thereby becoming personal & tacit to that reader.

2. Copyrights are rights traditionally granted to creators of artistic and literary works. These rights have, however, been extended over time to include:

- artistic works such as choreography; drawings, motion pictures, musical compositions, paintings, photographs, sculptures and works of architecture;
- literary works such as novels, poems, plays and reference works, and,
- commercial or utilitarian works such as advertisements, computer programs, databases, maps and newspapers.

3. Copyright is granted to natural and legal persons. When granted to a natural person it endures for the life of the artist/creator plus a fixed number of years that varies between countries, *e.g.*, in Canada for fifty and in the United States for seventy-five years. Copyrights granted to legal persons are also for a fixed number of years that also varies between countries. In the Civil Code tradition, however, natural persons receive certain imprescriptible rights not available or transferable to legal persons, *e.g.*, *droit de suite* or rights of following sales for works in the visual arts as well as moral rights of all artists. Some Civil Code rights have been adopted by Anglosphere countries, *e.g.*, Canada, but they remain transferable to legal persons by contract, extinguishing rights of the original creator. Copyright cannot be renewed.

4. As noted above, over time copyright protection has been extended from books to maps and charts, sheet music, photographs, sound recordings and motion pictures. Until the 1980s, however, copyright was, in all Anglosphere countries, restricted to ‘works of art’. With introduction of software copyright, however, utilitarian works received copyright protection for

the first time, and probably not the last. Copyright can emerge from any of the three knowledge domains – NES, HSS or the Arts – and can be obtained by natural and legal persons.

5. Two additional observations are in order. First, the first patent provision in the United States was a footnote to the copyright provisions of the 1784 South Carolina “Act for the Encouragement of Arts and Sciences.” What makes this provision important is that it so closely coupled patent with copyright protection, assigning the former as most appropriate to “machines”, and the latter to “books”, with little difference in their treatment. The Constitutional Convention of 1787 was influenced by this Act and spoke also of securing exclusive rights for “Authors and Inventors” to “promote the Progress of Science and useful Arts”. Neither copyright nor patents for invention were, however, explicitly mentioned ([David 1992](#)).

6. Second, there is the question of works by employees. Under Anglosphere copyright all works created by an employee are, unless by contract stated otherwise, the property of the employer. The employee cannot even claim paternity to his or her work. This is not the case under the Civil Code where paternity of the employee is preserved.

7. In the constitutional monarchies of the British Commonwealth, the State also exercises ‘Crown copyright’ over works created by servants of Her Majesty. In the United States, there is no equivalent of Crown copyright but rather a tradition that tax payers having paid for such work they fall into the public domain. In the case of patents, any invention created during company time by an employee is, by contract, automatically licensed to the employer but the patent application must be done in the name of the employee, *i.e.*, paternity is maintained. This is the case in both Common Law and Civil Code countries.

8. There is, however, one prominent Anglosphere exception to employer copyright: the university. Following the tradition of academic freedom, copyright to works by professors is, by contract, theirs and theirs alone. This exception has, arguably, resulted in the separation of the financial and career interests of scholars from that of their host institutions. Multinational communications conglomerates have, in effect, filled the gap between the two. Four or five global firms now control copyright for the world’s most prestigious scientific journals written by academics employed by universities and colleges and often paying ‘page fees’ to have their works published. This in an industry in which publish or perish is the rule. In turn, employers – the universities - now pay escalating library subscription fees for works authored by their own employees. This has resulted in a shrinking supply of periodical publications for students in all knowledge domains (*The Economist*, August 5, 2004). In response to these educational and

financial costs, the [Association of Research Libraries](#) in the United States, among others, are developing web-based alternatives to ‘commercial’ academic publishing.

9. Trademarks (and marks of origin) are devices such as a word, logo or other mark pointing to the origin or ownership of a good or service that is reserved for the exclusive use of its owner as maker or seller. Today, its application has, *de facto*, been extended to ‘[domain names](#)’ on the internet or world-wide web. The World Intellectual Property Organization (WIPO) has thus established dispute settlement mechanisms to resolve ‘cyber squatting’, *i.e.* registering a domain name using the name or trademark of an established business enterprise or celebrity, *e.g.* Julie Roberts, with the intention of selling that registration to its recognized trademark holder for a profit. At the international level, however, only the *Common Industrial Property Regime of the Andean Community* of 2000 makes explicit reference to web domain names ([Chartrand 2001](#)). If a trademark takes the form of a logo, it emerges from the Arts; if it takes the form of a name or word then arguably it emerges from the HSS.

11. The word ‘trademark’ entered the English language in 1838 (OED, *trademark*, n, a). Functionally, however, it can be traced back to ancient times and in Western Europe from at least the 13th century including masons marks, goldsmiths marks, paper makers’ watermarks and watermarks for the nobility, and printers’ marks. While the 1618 case of *Southern v How* is considered the birth of commercial trademark law in England, the first national trademark legislation was enacted in France in 1857 followed by Britain in 1862. In the United States, the first trademark legislation was passed in 1870 based on the patent and copyright clause of the Constitution. It was, however, subsequently repealed and replaced in 1881 with legislation based on the commerce clause of the Constitution. This legislation was intended to allow trademarks to be used in commerce with foreign nations and Indian tribes ([University of Texas Libraries 2004](#)). In Britain, the *Trade Marks Registration Act* of 1875 required a legal register of marks and the first Trade Marks Registry in the world opened in London in 1876 ([UK Patent Office 2003](#)).

11. Registration and the payment of fees are required. A trademark is granted only for new marks so as not to confuse the public. It is available to both natural and legal persons. And, unlike other forms of IPRs, trademarks can be renewed, potentially in perpetuity.

12. While copyrights and trademarks share a non-utilitarian matrix they belong to two different classes of rights. The overtly commercial nature of industrial designs, patents and trademarks place them in a distinct legal category called ‘industrial property’, subject of the first international intellectual property rights convention, the *Paris Convention for the Protection of*

Industrial Property of 1883 (Chartrand 2001). The ‘artistic’, ‘personal’ or ‘semiotic’ nature of copyright, by contrast, rooted in the European Civil Code tradition, is recognized in a separate set of international conventions beginning with the *Berne Convention for the Protection of Literary and Artistic Works* of 1886 (Chartrand 1998). The difference was summed up by Keyes and Brunet:

Though copyright is expressed in terms of property, it is not directly analogous to industrial property (patents, trademarks and industrial designs), where the major concern is with the circulation of goods that have economic value apart from their intellectual content. As it deals with purely intellectual matter, copyright can never interfere with a person’s physical well-being. (Keyes & Brunet 1977, 3)

11.3.2 Designs & Patents

1. Designs and patents use a utilitarian matrix to embed or tool knowledge into a tangible material and functioning form. Knowledge for design is mainly from the Arts; for patents, mainly from the natural & engineering sciences.
2. Industrial design involves the arrangement of elements or details that contribute a distinctive aesthetic appearance rather than a function to a good. In this sense there is a relationship between copyright protecting a work of art and industrial design. Both involve aesthetics but in the case of a copyright the aesthetic element is fixed in a matrix that has no utilitarian value. By contrast the aesthetic element of industrial design is fixed in a utilitarian matrix, *e.g.*, a coffee cup without a design retains its function. In addition, an original work of art tends to be unique while an industrial design is usually produced in large numbers. This last distinction, however, is of diminishing significance with the maturation of the Media Arts as a distinctive artistic discipline.
3. Industrial design protection can be obtained by both natural and legal persons. Industrial design emerges from the Arts. It is important to note, however, that industrial design evolved from copyright in the British Commonwealth but from patents in the United States. Design protection is granted for a fixed time period (for example, 14 years in the United States) after which the design enters the public domain. Registration and payment of fees are required. Industrial design cannot be renewed.
4. The first design-related legislation in Britain was the *Designing & Printing of Linen Act* of 1787. The *Copyright of Design Act* of 1839 extended protection to other textiles but it was not until the *Design Act* of 1842 that protection was extended to other manufactures including designs made up of functional elements (UK Patent Office 2001). In the United States, an 1842

statute granted a design patent for new and original designs for a manufacture or printing on a fabric (Ladas & Parry 1999). In the American case, industrial design protection thus developed out of patents.

5. Since the 15th century governments in the West have granted legal protection, enforced by the coercive powers of the State, to those who create or make available knowledge new and useful to that State. This reflected the emergence of the Renaissance artist/engineer/humanist/scientists to genius status. At first import patents were granted to foreigners bringing new working knowledge to the kingdom (David 2001, 7). Thus the first known English patent was granted by Henry VI to Flemish-born John of Utynam in 1449 for a method of making stained glass not previously known in England but required for the windows of Eton College. Gradually such protection was extended to domestic inventors (UK Patent Office, 2004).

6. Patents are granted for new and useful compositions of matter (*e.g.*, chemical compounds, foods, and medicinal products), machines, manufactured products and industrial processes as well as to improvements to existing ones. In some jurisdictions, patents can also be granted to new plant and animal forms developed through genetic engineering. This includes asexually propagating plants, *e.g.*, using cuttings. Patents, unlike industrial design, emerge from the natural & engineering sciences rather than the Arts.

7. Through case law and amendment, U.S. patents have, over time, evolved into three types: patents of invention, design patents and plant patents. In all cases, registration is required and fees must be paid. To be patentable, an invention, design or plant must be novel, useful and, non-obvious “to one of ordinary skill in the art.”

8. A description must be deposited, in writing and drawings, sufficiently detailed to allow one of ordinary skill in the art to replicate the invention. This insures that new knowledge enters the public domain while the rights of the inventor are protected. In the case of microorganisms, description can take the form of a deposit of a sample with an authorized depository. Patent protection is for a fixed period of time (in the U.S., currently 20 years from the date of filing) after which it enters the public domain. It can be obtained by natural and legal persons. In general, these terms and conditions hold in all countries in the Anglosphere tradition. Patents cannot be renewed.

9. The term ‘patent’ entered the English language in the 14th century. Patents for invention were originally just one form of monopoly granted by the British Crown. Such grants were signified by Letters Patent, open letters marked with the King’s Great Seal.

11. By the time of James I, abuse of the monopoly system had become so great that the *Statute of Monopolies* was enacted in 1624. It made all patent monopolies illegal except for “any manner of new manufactures within this Realm to the true and first inventor”. Furthermore, such monopolies could not be “contrary to the law nor mischievous to the State by raising prices of commodities at home or hurt of trade”. For some 200 years the patent system in Britain developed through case law without statute. It was not until the *Patent Law Amendment Act* of 1852 that a formal patent act came into existence ([UK Patent Office](#), July 13, 2004).

11. The first U.S. patent act: “An act to promote the Progress of Useful Arts” - was passed in 1790. Its legal status was based, however, on Article 1, Section 8, Clause 8 of the 1787 Constitution of the United States which states: “Congress shall have power ... to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.”

11.3.3 Know-How & Trade Secrets

1. Know-how and trade secrets use a person – natural or legal - to embed knowledge in material form. Secrecy is used to protect both types and in most countries there is no formal statute. Trade secrets and know-how are the least formally protected of all intellectual property rights.

2. The term “know-how” entered the English language in 1838 (OED, *know-how*). It refers literally to knowing how to do something, *e.g.*, how to run a construction project. It includes knowledge and experience of an administrative, commercial, financial or technical nature used in running a business or performing a profession. It is experiential in nature, *i.e.*, it is acquired through practice and experience. It also tends to be ‘personal & tacit’ rather than ‘codified’ and embodied in an individual rather than in an external matrix. In most countries, know-how is protected by contract binding employees and other agents to confidentiality. When a natural or legal person (including a government) discovers that know-how has been revealed by an agent without permission, legal recourse is available through breach of contract before the courts. No registration is required. Know-how can be protected without time limit. It can emerge from any of the three knowledge domains – NES, HSS or the Arts.

3. Trade secrets involve information of a technical or commercial nature that is not in the public domain nor generally available. It may be a formula, pattern, physical device, idea, process, compilation of information or other information that provides a competitive advantage in the marketplace. It is generally protected by contracts that bind employees and other agents to

confidentiality. Normally the courts require that a trade secret be treated by its owner in such a manner that it can reasonably be expected to prevent the public or competitors from learning about it except by improper acquisition or theft. In the case of electronic data this includes using encryption and “password” technologies. The most famous trade secret is the formula for Coca-Cola. A trade secret may be embodied in written or other codified form or it may be personal & tacit in a natural person. No registration is required. There is no time limit as long as it remains secret. It may emerge from any of the three knowledge domains – NES, HSS or the Arts.

4. While know-how and trade secrets are often used as synonyms they need not be so. In the case of management and franchises, for example, know-how is usually accessible to third parties when being used. Single elements may be kept secret but the overall concept cannot be. Where in a nation’s judicial hierarchy infringement of trade secrets or know-how may be heard varies, *e.g.*, in the United States it is at the State level. Some international conventions, *e.g.*, TRIPS and the Andean Pact Industrial Property Convention recognize infringement of both. In effect, when a senior executive moves from a company in one country to one in another signatory country, an international ‘legal’ lobotomy is in force; the executive and new employer may both be held liable for any infringement. In William Gibson’s future world of *Neuromancer*, corporations (and governments) protect their know-how and trade secrets by implanting “neural bombs” (Gibson 1984). If an employee’s loyalty slips, the bomb goes off killing or mentally maiming: the bottom line - the knowledge is protected.

11.3.4 Sui Generis

1. *Sui generis* in Latin means “of its own kind”. There are a number of recognized *sui generis* property rights. The United States, in particular, has made extensive use of such rights including: breeders’ rights for lines of plants and animals generated using pre-genomic selective breeding technology; a special depository right for microorganisms in lieu of traditional patent requirements of a written description and drawings; special rights for visual artists of recognized stature; special rights for architectural works; and, special rights for integrated circuit typographies, the so-called ‘Chip Protection Act’. The European Commission’s Directive on the Legal Protection of Databases is another example of:

a new form of copyright in databases, one that extends to contents previously in the public domain and otherwise not copyrightable. It narrowly restricted the application of the principle of allowing exclusions for “fair use” in research, and it permitted virtually indefinite renewal of copyright protection for databases without requiring the substantial addition of new and original content.” (David 2000, 6)

2. It can be anticipated that many new *sui generis* rights will emerge as nations compete by combining different elements drawn from their own traditions governing copyright, designs, patents, trademarks, trade secrets & know-how. The only constraint under the WTO and other international trade rules is national treatment

11.4 The Public Domain

1. In a sense the public domain is an unexplored country whose borders can be outlined but whose interior remains unknown, unexplored and uncharted. Thus James Boyle notes that the 2001 Duke University law conference on the public domain was “the first conference on the subject” (Boyle 2003a, 1). Furthermore, he identifies David Lange’s 1981 article “Recognizing the Public Domain” as having “really initiated contemporary study of the subject” (Boyle 2003b, 59). In this unknown country resides the vast bulk of human knowledge acquired through all four faculties of knowing in all knowledge domains and practices throughout human experience including pre-history. To paraphrase Rosenberg on science, the body of knowledge called the public domain consists of an immense pool to which small annual increments are made at the frontier. The true significance of the public domain is diminished, rather than enhanced, by extreme emphasis on the importance of the most recent increment to that pool, *e.g.*, IPRs (Rosenberg 1994, 143).

2. For the competitiveness of nations in a global knowledge-based economy, such ignorance cannot continue. To cure it, however, requires accepting the inherent limitations imposed by the immeasurability and incommensurability of knowledge. Accordingly, trans-disciplinary induction is used and a circumambulation of the question conducted looking at it from a number of different perspectives and interpreting findings as symbolic of its numinous meaning (Neumann 1954, 7). Put another way: “A definition can be but one of many definitions, each surely a function of perspective and agenda” (Lange 2003, 463). At this time, I will examine the public domain as:

- economic commons;
- legal principle and precedent, and,
- constitutional & cultural history.

11.4.1 Economic Commons

1. As will be demonstrated in greater detail in the next chapter (12.0 Economics), like technological change in economics, the public domain is, in law, traditionally treated as a

residuum. Traditionally in economics after the contribution of changes in capital, labour and natural resources to economic growth has been calculated, the residual is technological change. In law, after new knowledge has been ‘privatized’ as intellectual property, what remains is the public domain (David 2000, 15). In this sense, the public domain is the opposite of property (Boyle 2003a).

2. Extending the parallel, the public domain is where knowledge is at home as a public good, *i.e.*, non-excludable and non-rivalrous, acting, as will be seen below, like disembodied exogenous technological change. Everyone has the right to know; it falls from heaven like manna (Scherer 1971, 347). Knowledge covered by intellectual property rights, on the other hand, is rivalrous and excludable by law, if not by nature. It is embodied (fixed) in a work of aesthetic or technological intelligence that is the possession of its creator (or, more usually under Common Law, a corporate proprietor) who determines access and application. To put it another way, where intellectual property rights privatizes or encloses new knowledge (Boyle 2003b) and limits access through price and other mechanisms, knowledge in the public domain is free to all without cost or restriction.

3. The public domain has also been considered an intellectual or public knowledge commons (David 2000). In general, an economic commons is a natural resource shared by all but owned by none. Problems of over-use and depletion of such common resources, *e.g.*, fish in the seas beyond the territorial limits of any Nation-State, has been called the “tragedy of the commons” (Hardin 1968). Mainstream economics recommends creation of property rights, *i.e.*, privatize ownership of the resource to guarantee its survival through the operation of self-interest on the part of its new owner or owners (*e.g.*, Demsetz 1967).

4. This argument has been extended to the encouragement of new knowledge through intellectual property rights that, in effect, privatize new knowledge. The economic rationale is that given the public goods nature of knowledge, a producer cannot capture revenues to cover costs, let alone earn profits, in the absence of such rights. The resulting monopoly, *e.g.*, copyrights and patents, are justified, however, by full public disclosure of new knowledge, *e.g.*, through full patent application disclosure or publication and its *eventual* total and complete absorption into the public domain. Society benefits because expansion of the public domain contributes to economic growth by enriching the knowledge base of everyone who wants to know.

5. The public domain, however, is unlike any natural resource commons. Most obviously, the public domain is artificial - it is human-made. And, as Herbert Simons stresses, there is a

need for a clear epistemological distinction between the sciences of nature and “the sciences of the artificial” (quoting Simons [Layton 1988](#), 91). Similarly, a clear distinction must be made between the economics of the public domain and those of natural resources.

6. In many ways the public domain is the inverse of a natural resource commons. First, use of the public domain does not reduce the quantity of resources available to others. Second, in its normal state the public domain grows and will continue to grow until the collapse of human civilization in its contemporary incarnation. Such growth may be slowed by IPRs and other impediments but the biological need to know insures growth of the public domain. Third, while there can be no subtractions from the public domain through use, additions are not simply additive. Rather, additions combine with existing knowledge mutating and generating yet more new knowledge. Or, in terms of Isaac Newton’s famous aphorism: “If I have seen further it is by standing on the shoulders of Giants.” The public domain is not a domain of scarcity but of fertile abundance. In this sense the public domain, unlike any natural resources commons, exhibits increasing returns to scale.

11.4.2 Legal Principle & Precedent

1. Paul David has observed that intellectual property rights have not been created “by any rational, consistent, social welfare-maximizing public agency” ([David 1992](#)). The resulting IPR regime he characterizes as ‘a Panda’s thumb’, *i.e.*, “a striking example of evolutionary improvisation yielding an appendage that is inelegant yet serviceable” ([David 1992](#)). In the case of the public domain, he observes that “what it contains is not defined and legal ‘rights’ to its use are not delineated” ([David 2000](#), 15). This legal lacunae is the result, I argue, of an inherent clash between the public domain interpreted as a legal principle and as a legal precedent.

2. The term ‘public domain’ entered “Anglo-American copyright discourse through the French of the Berne Convention” in 1886 ([M. Rose 2003](#), 84). The public domain is thus rooted in the European Civil Code based on principle rather than precedent. In turn, the Civil Code draws heavily on the old Roman law especially the *Institutes of Justinian* from which Justice Yates argued that ideas are like wild animals belonging to everyone and no one. Observing the relative lack of interest in the concept of common property over the last three hundred years of Anglosphere legal tradition, Carol Rose has tried to revivify Roman concepts of public property lacking in the English-speaking tradition. In effect, she concludes that the evolution of Anglosphere law has been dominated by questions about private, not public, property ([C. Rose 2003](#)).

3. There are five categories of public property under Roman law: *res nullius*, *res communes*, *res publicae*, *res universitatit* and *res divini juris*. To begin, the Latin word *res* means ‘thing’. *Res nullius* refers to things that are unowned or have simply not yet been appropriated by anyone such as an unexplored wilderness. *Res communes* refers to things that are open to all by their nature, such as oceans and the fish in them. *Res publicae* refers to things that are publicly owned and made open to the public by law. *Res universitatit* refers to things that are owned by a body corporate, *i.e.*, within the group such things may be shared but not necessarily outside the group. Finally, *res divini juris* (divine jurisdiction) refers to things ‘unownable’ because of their divine or sacred status ([Kneen 2004](#)).

4. While arguably knowledge exhibits all five characteristics, for now, I restrict myself to contending that the Civil Code public domain derives from such Roman legal concepts. They are not, however, the underlying source of Anglosphere usage. Precedent is its source. In this case the precedent is two-fold. First, import patents were introduced in 15th century England to increase the national knowledge-base (the economic public domain) and hence competitiveness. They were granted for fixed periods (usually 14 years corresponding to two generations of apprentices who could work for the foreign ‘inventor’ but not compete). After the patent lapsed the knowledge became available to the third generation and beyond, *i.e.*, the knowledge entered the economic public domain ([David 1992](#)).

5. Second, as will be described in greater detail below, copyright began in the 15th century as a licensing law for a new technology: the printing press and its entrepreneurial owner – the printer. Licenses were required for *everything* printed in order to control heresy and sedition. It quickly became apparent to the Tudor monarchs (as well as those of continental Europe) that it was much easier and effective to control a limited number of presses than a large number of subversive or heretical authors. A hand written manuscript could, after all, be read by only relatively few; typeset copies, on the other hand, could be read by and corrupt many. Copyright licenses granted to printers were perpetual, at the pleasure of the Crown, and no rights were granted to the author.

6. Three conclusions can be drawn. First, in the Anglosphere tradition the public domain is what the government of the day says it is, *i.e.*, it is a political decision, it is not ‘natural law’ based on principle. Second, the public domain constitutes the shared or common knowledge-base of the national economy. Third, flowing from the first two, the Anglosphere public domain is continually threatened by the monopolistic tendencies of printers and their proprietary descendents. As will be demonstrated, history has emboldened proprietors to use the image of the starving artist as a foil to extend their monopoly and expand profits. In the 1750s, this

played out as the ‘Battle of the Booksellers’ (Paterson 1993). Today, it is called the ‘Second Enclosure Movement’ fueled by, among other things, the ubiquitous spread of blanket licenses (Boyle 2003b). In a sense, the Anglosphere public domain can be cited as a triumph of precedent over principle. To understand why, however, requires a different focus, that of the constitutional and cultural history of the public domain.

11.4.3 Constitutional & Cultural History

1. After Parliament crushed the royal prerogative to issue letters patent with the 1624 *Statute of Monopolies*, for some 200 years the patent system in Britain developed through case law without statute. It was not until the *Patent Law Amendment Act* of 1852 that a formal patent act came into existence (UK Patent Office, 2004). The first U.S. patent act: “An act to promote the Progress of Useful Arts” - was introduced in 1790. In both countries, however, there was no perceived conflict between the patent monopoly and the public domain because of its relatively short duration after which any embodied or tooled knowledge entered the public domain growing the national knowledge-base. This relatively quiet development was not, however, the case with copyright whose development is intimately linked to freedom of the press, the public domain, popular democracy and our rights to know in general. Accordingly, I offer a somewhat detail review of these developments in the UK and the United States.

2. The word ‘copyright’ itself entered the English language only in 1735 (OED, *copyright*). Nonetheless, with the introduction of William Caxton’s printing press (the first engine of mass production) in 1476, the first copyright law was, in effect, introduced (Chartrand Fall 2000). Under Common Law, many rights initially derive from inscribing or copying one’s name and explaining one’s ‘title’ to property on a register. Thus in medieval England to obtain the right to farm a particular piece of land, one’s name had to be inscribed or written, by oneself or a scribe of Church or State, on a register of tenants. This was, and still is, called ‘copyhold’ to the land. With introduction of the printing press, licensing laws required printers to inscribe their name, location and titles of works they wanted to print on a register. If approved by the Crown for publication, a *copye* was granted to the printer. The rights flowing from this *copye* constituted “copyright” and were held in the name of the printer, not the author. This copyright was perpetual, held at the pleasure of the Crown. “The question of rights of authorship was largely disregarded, since much of the demand was for extant works (like the Bible) that were in the public domain, and whose authors - even when identified - were long since dead” (David 1992). As for living authors, they were treated according to the Renaissance tradition of the

honorarium, i.e., an initial one-time payment extinguishing all rights to the work (Woodmansee 1984, 434). Under contemporary copyright, this is called an ‘all rights’ or ‘blanket license’.

3. The religious wars that swept over Western Europe after the Protestant Reformation of the 16th century reached England but took a peculiar constitutional as well as religious twist: Caesarpapism. German Protestants fought the Petrine Doctrine of the Church of Rome claiming the Pope as successor of St. Peter. In England, however, Henry VIII also broke with Rome but using the competing Caesaropapism Doctrine of the Byzantine Church claiming the king as God’s anointed Vicar on earth in the tradition of King David, i.e., the Divine Right of Kings (Cantor 1969, 55, 90). In one stroke, Henry VIII achieved what had eluded western Europe since the fall of Rome – the marriage of Church and State. He followed up with an official translation of the Bible into English which was published in 1539. This literary break with Latin was only finalized, however, with the King James’ version in 1611 which became *The Great Code* of the English language (Frye 1981).

4. Thus, unlike continental Europe, England fractured into three not two warring camps: Catholic, Protestant and Anglican or Church of England. This trinary power struggle for the soul of England was to have profound implications for the development of the natural experimental sciences; definition of the public domain as freedom of the press; increasing tolerance of religious difference; and, in the United States, constitutional separation of Church and State.

5. In 1557, Queen Mary granted a charter to what became the Company of Stationers of London. Stationers’ Copyright was based on royal prerogative or letters patent covering the entire publishing industry as an estate. This monopoly was assigned to members as a freehold interest. No consideration was given to author’s rights. The Stationers’ Company was the only monopoly to escape dissolution under the *Statute of Monopolies* in 1624. The reason was its political utility in fostering the political and religious orthodoxy of the day (Patterson 1993).

6. From the death of Henry VIII, England entered a time of troubles. Each ruler – the Catholic Mary, Anglicans Elizabeth I & James I, quasi-Catholic Charles I, Puritan Cromwell, quasi-secular or sensualist Charles II, Catholic James II and the first constitutional monarch, Queen Anne – faced opposition from two-thirds of the population and struggled to maintain political and religious control. By restricting freedom of the press they tried to limit what could enter the public domain of thought and debate. The instrument of control was the licensing law that maintained the perpetual copyright of the Stationer’s Company.

7. Two key developments are of relevance to the question at hand. The first was the Restoration of the monarchy in 1660 and the constitutional and cultural compromises that accompanied it. The second was the Glorious Revolution of 1689 that installed Queen Anne as the first constitutional rather than ‘divine’ monarch followed by passage of the first modern copyright act, the *Statute of Queen Anne* of 1711. As will be seen these developments continue to haunt contemporary policy debate about intellectual property rights, our rights to know as citizens and the global knowledge-based economy.

8. First, during Cromwell’s Commonwealth or Protectorate, the Protestants or Puritans were the titular winners but they were divided into many squabbling sects and could not agree among themselves. Cromwell, as Lord Protector, tried to mitigate their differences as well as those of Catholic and Anglican citizens. In the end, however, the monarchy was restored after his death. It was during the Protectorate, however, that the great Latitudinalist compromise of Robert Boyle was made (Jacob 1978; Jacob & Jacob 1980). Theologically, Boyle freed Anglican, Catholic and Protestant to read God’s other book, the book of nature using the new experimental philosophy. His success was marked by Charles II chartering the Royal Society in the year of the Restoration 1660. It was also during the Protectorate that the living author began to compete with the ancients and John Milton in his 1644 *Areopagitica* (1608-1674) began the cry for freedom of the press. Subsequently, John Locke (1632-1704), in his *Memorandum* of 1694, argued for freedom of the press and against both Stationers copyright and perpetual copyright for the author.

9. Second, the final constitutional battle between the Monarchy and Parliament occurred with “The Glorious Revolution of 1689” when the last of the Stuart monarchs, the catholic James II, was deposed by an Act of Parliament and replaced by his ‘protestant’ daughter Mary and her consort William of Orange. The resulting ‘Bill of Rights’ established free speech in Parliament marking the beginning of a ‘free press’ in England.

10. In 1695 the last of the *Licensing Acts* lapsed. Government control was henceforth limited to post-publication libel law. Suspension further spurred development of a free press that could publish without prior consent of the authorities. Without the Licensing Act, however, the Stationer’s Company perpetual copyright also lapsed and a rival appeared on the horizon – Scotland. While England and Scotland had been under the same monarch since 1603 they remained separate countries with separate legislatures and separate laws. This meant that the Stationer’s Company’s copyright did not have force in Scotland. As long as the licensing laws were in place London booksellers could limit competition. With their expiration, however, competition began to grow.

11. There were many attempts by the Stationer's Company to restore the old licensing system in the late 1690s and early 1700s, but it was not until 1710 that a new copyright system came into force. In fact between 1695 and 1710, Scottish and domestic 'pirates' made it increasingly difficult for London booksellers. Without the protection of a Licensing Act, any pirate could take a successful work, re-typeset it and then sell it at a much lower price with no payments for the author, to the editor or for promotion.

12. *An Act for the Encouragement of Learning, by Vesting the Copies of Printed Books in the Authors or Purchasers of such Copies, during the Times therein mentioned*, more commonly called the *Statute of Queen Anne* of 1710, had three objectives. First, it was intended to prevent any future monopoly of the book trade. Second, it was intended to draw Scotland under a common copyright law and thereby to resolve the piracy controversy. Third, it was intended to encourage production and distribution of new works. The vehicle chosen to achieve all three objectives was the author.

13. Until the Statute, the author had no economic and limited moral rights to a work after it was sold. Generally, a work was bought outright by a printer/bookseller/publisher for a flat one-time fee much like an all-rights or blanket license today. No royalties flowed to the author from subsequent sales. They did enjoy certain 'moral rights' including the right not to have the text changed and the right of attribution. Such rights, however, were based on ethical practices of the printers' guild, not law.

14. The *Statute of Queen Anne* is considered the turning point in the history of copyright because it was the first law to formally recognize an author's rights and, more importantly, it ended prior government censorship through pre-publication licensing of works. Recognition of an author's rights by the Statute was, however, principally a device to attain its primary objective - abolition of the Stationer's monopoly (Feather 1988, 31-36). In effect, it was a trade regulation bill and did not recognize inherent and inalienable rights of the author (Shirata 2000).

15. In the end, the *Statute of Queen Anne* granted an extension of the existing copyright monopoly of the Stationer's Company for 21 years and granted an exclusive right for new works for fourteen years with an option to renew for the same period. Furthermore, the Statute recognized the author as the initial copyright holder to encourage "learned men to compose and write useful books". However, it also *explicitly* recognized the financial interests of "proprietors" who, by sale or assignment of the author's initial copyright, were almost invariably printers/booksellers/ publishers.

16. The Stationer's Company, however, did not give up. The London booksellers told tragic tales of piracy ruining honest businessmen, their wives and children. Literary works were the inheritances of innocents and pirates were, in effect, stealing food from the mouths of babes. These tales of piracy were adopted not just by the booksellers but also by those advocating authors' rights and were used to illustrate the implications of lax copyright protection for authors. It is important to keep this distinction in mind: printer's copyright vs. author's rights. The episode was called 'the Battle of the Booksellers' (Shirata 2000).

17. A number of cases were brought to court by printers/ booksellers/publishers during the 1750s and 1760s to gain recognition of a common law copyright independent of the statutory rights established by the *Statute of Queen Anne*. Publishers argued that an author is entitled to enjoy the fruit of his labor, just like all other forms of property - in perpetuity. A publisher, being merely an assignee of the rights of the author, should therefore also enjoy such rights in perpetuity independent of statute. It was not, however, until 1769 that a legal decision was rendered on the issue in *Millar v. Taylor*. Lord Justice Mansfield decided, with the majority, in favour of an author's perpetual copyright while Justice Yates, as has been seen, opposed it.

18. Sir William Blackstone contributed to the plaintiffs' cause. Blackstone had previously published *Commentaries on the Laws of England* in 1767 in which he interpreted copyright for the first time as a legal concept (Blackstone 1771, 400-407). Using Lockean natural law theory (Locke 1690), he described copyright as a kind of personal property in common law on the ground that any kind of published work is based on the author's brainwork. This became known as 'the sweat of the brow' theory. Of course, in his 1694 *Memorandum*, mentioned above, Locke explicitly rejected perpetual copyright.

19. The plot of the booksellers was, however, ultimately defeated in 1774 by the decision of the House of Lords in *Donaldson v. Beckett*. It was this decision that established the basic concept of Anglosphere copyright. When an author fixes his creation in a tangible medium, he obtains a common law right that is eternal in nature. However, he loses this common law right with publication, or, 'dedication to the public'. In effect, the House of Lords accepted the dissenting opinion and reasoning of Justice Yates in *Millar v. Taylor*:

20. What is at issue is that the living author had attained the status of genius, someone who produces with god-like powers out of nothing (Woodmansee 1984). However, the reward for such genius was qualified by Enlightenment rights of the public at large (M. Rose 2003, 76). Thus while in a sense the work of the artist, author or inventor was god-like and qualified as *res*

divini juris, they were also *res communes* - open to all by their nature and *res publicae* publicly owned and made open to the public by law.

21. The change, however, was less a boon to authors than to publishers because it meant that copyright was to have another function. Rather than simply being the right of a publisher to be protected against piracy, copyright would henceforth be a concept embracing all the rights that an author might have in his published work. And since copyright was still available to the publisher, the change also meant that the publisher as copyright proprietor would enjoy any new rights granted the author by appropriation (Patterson 1968).

22. Thus, what started out in 1710 as a statutory device to regulate the book trade, prohibit monopoly and end pre-publication censorship, was transformed, at least in the popular imagination, into a ‘natural law’ for the encouragement, protection and reward of authors. In reality, however, author’s rights - economic and moral – were effectively sacrificed to the pecuniary interests of Proprietors. Once a work was typeset and published the author’s Common Law rights vanished like a wild animal into the forest leaving behind a Proprietor enjoying the rights and privileges granted by an admittedly now time limited monopoly.

23. It has been argued that the public domain only came into existence with the end of perpetual copyright (M. Rose 2003). And this was the state of English law in 1776 after which the laws of England were transformed into the Common Law of a post-revolutionary United States of America. While there were Licensing Acts in most of the colonies, before the 1780s only Massachusetts had a formal copyright statute. There were three reasons:

24. First, despite the fact that works of American authors were published in America, the number of works was limited and a large proportion of the American market was dominated by British authors. Second, authors in the colonies were usually also editors and publishers themselves. There was a sentiment or trade rule called “courtesy copyright” or “mutual obligation” among publishers, which effectively suppressed piracy. Third, there was little or no conflict of market share among publishers on account of the extensive and growing American market. The market was also strictly segmented. Each publisher often supported a specific political group (Shirata 2000).

25. A year before the House of Lords made its decision on *Donaldson v. Beckett*, the Boston Tea Party marked the beginning of the American Revolution. Between 1773 and 1783 the United States was at war with Great Britain and there was no trade between the two – including in law books and legal decisions.

26. Accordingly, the last major copyright decision of the British courts current in legal circles in the United States was *Millar v. Taylor* of 1769. The majority opinion penned by Justice Mansfield - that there was a 'natural' perpetual author's copyright - held sway unqualified by the subsequent decision of the House of Lords in *Donaldson v. Beckett*.

27. As the revolutionary war played itself out the publishing industry in the colonies increasingly turned towards American authors. However, the trade courtesy that protected printer/publishers afforded no protection to authors. Some authors began to lobby for 'copyright' protection confusing 'author's rights' with the traditional copyright granted to printers.

28. The framers of the United States Constitution, suspicious of all monopolies, knew the history of copyright as a tool of censorship and press control. They wanted to assure that copyright was not used as a means of oppression and censorship in the United States (Loren 1999). This consuming fear of monopoly and censorship is captured in the words of Thomas Jefferson: "I have sworn upon the altar of God, eternal hostility against every form of tyranny over the mind of man." (Letter to Dr. Benjamin Rush, September 23, 1800).

29. And, with respect to the copyright monopoly and the 1774 reasoning of Chief Justice Mansfield in *Millar v. Taylor*,

Thomas Jefferson, in 1788, exclaimed: "I hold it essential in America to forbid that any English decision which has happened since the accession of Lord Mansfield to the bench, should ever be cited in a court; because, though there have come many good ones from him, yet there is so much sly poison instilled into a great part of them, that it is better to proscribe the whole."
([Commons 1924](#): 276)

30. The US Constitution was adopted in 1787 and ratified a year later. Article I, Section 8 of the Constitution is now known, alternatively, as the 'Intellectual Property', 'Copyright' or the 'Exclusive Rights' Clause ([Benkler 2003](#)) and states "The Congress shall have Power... To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."

31. The importance of the clause is evidenced by the fact that the power to promote 'progress' was one of very few powers to regulate commerce initially granted to Congress. Two years after ratification of the US Constitution, Congress passed the first *Copyright Act* of 1790: *An Act for the Encouragement of Learning, by securing the Copies of Maps, Charts and Books, to the Authors and Proprietors of such Copies, during the Times therein mentioned*. Two things are important with respect to the title of the Act. First, Article 1, Section 8 of the Constitution assigns rights to 'Authors and Inventors' reflecting the proximity of copyright and patents and its

relationship to the natural person as genius. The 1790 Act, however, assigns rights to ‘Authors and Proprietors’. As in England, author’s rights were compromised in favour of the pecuniary interests of proprietors who increasingly were legal not natural persons. The Common Law fiction that natural and legal persons have the same rights thus allows bodies corporate to hold copyrights justified as a reward for individual creativity.

32. Second, its title derives from the *Statute of Queen Anne* justifying the ‘securing the Copies’ as an encouragement for learning among the people. The importance of ‘learning’ led to the ‘Fair Use’ clause of the U.S. Copyright Act limiting copyright even during its duration. In the simplest terms, it means: nonprofit, non-financially damaging copying is fair use. This provision allows public libraries, educational institutions and individuals to lend or copy works without paying royalties and avoid copyright infringement. This encouragement of learning, of course, amounts to increasing the personal & tacit knowledge-base of the nation.

33. Arguably, the First Amendment of the U.S. Constitution is directly related to copyright and hence to an American concept of the public domain ([Alstyne 2003](#)):

Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people peaceably to assemble, and to petition the government for a redress of grievances.

34. The historical connection between the two is the pre-*Statute of Queen Anne* Licensing Acts which were used to control the press, restrict religious and political debate and thereby the public domain. These, at one and the same time, were used to restrict the press and maintain the perpetual copyright of the Stationer’s Company. In this sense, the First Amendment can be seen as a sibling of modern copyright with both serving to define the public domain. David Lange takes this argument further arguing that the public domain itself should be recognized as having a status analogous to citizenship with affirmative rights. “I want the public domain, however it may be defined, to secure these elemental aspirations which I believe innate in human kind: to think and to imagine, to remember and appropriate, to play and to create ([Lange 2003](#), 483).

35. To any mapping of the public domain charted by the First Amendment and the Copyright Act one must add the more recent *Freedom of Information Act* that makes all government information part of the public domain unless national security or commercial confidentiality are involved. This last caveat ‘commercial confidentiality’ opens onto yet another tributary, this one within the domain of the Security & Exchange Commission and the Department of Commerce. And the list goes on.

36. Unless the public domain as legal principle is reconciled with the public domain as legal precedent, Lange's vision will, however, remain unrealized. In fact, the progressive extension of the term of copyright in the United States, now approaching 100 years – life of the author plus 75 years – suggests, however, that *de facto* perpetual copyright has already returned. This sense is enhanced by the ubiquitous spread of all rights or blanket licenses that extinguish a creator's rights in favour of corporate proprietors who continue to press for more rights in order *to preserve the starving artist*. Increasing concentration of media ownership adds its own distinct monopolistic flavour to a brew that may realize Thomas Jefferson's worst fears about copyright. A second American revolution, a legal revolution, may be in order.

37. The situation in the constitutional monarchies of the British Commonwealth, however, is even more problematic. Unlike the United States with its constitutional separation of powers, a central principle of constitutional monarchy is 'the indivisibility of the Crown'. Power flows down in the name of Her Majesty, not up from the people as in republican systems. In federal constitutional monarchies such as Australia and Canada this indivisibility applies at the jurisdictional level, *e.g.*, the province of Saskatchewan in right of Her Majesty is indivisibly linked to the Dominion of Canada in right of Her Majesty. Similarly, the executive, legislative and judicial branches are subject to Her Majesty. As well, all private persons and property are subjects of Her Majesty. There can, accordingly, be no absolute private property rights. Everything and everyone is subject to the pleasure of Her Majesty. In political terms, this means, for example, that a 'Bill of Rights' such as the *Canadian Charter of Rights and Freedoms*, unlike the American First Amendment, is, in effect, subject to a 'notwithstanding' clause that allows a parliamentary or legislative majority ratified by Her Majesty's representative - the Governor General of the nation, or the Lieutenant Governor of a Canadian province - to abrogate any and all rights contained therein including a free press and the public domain.

11. 5 Reconciliation

1. What started out as an exploration of the economics of new knowledge as intellectual property rights or 'rights to know' has ended with the politics of the First Amendment of the U.S. Constitution and national constitutions in general. How? Arguably it was our trip through an unexplored country called the public domain. Therein a free press is historically linked to copyright and, indirectly, to the evolution of patents and intellectual property in general.

2. Arguably, Adam Smith's alarm about a 'political economy', *i.e.*, one in which economic profit translates into political power and political power translates into economic profit, is being recycled in modern times. The relationship between political power and economic profit is an

increasingly central theme of the knowledge-based economy. In the crudest terms, a knowledge-based economy means the monetarization of knowledge. Political power writes the intellectual property statutes defining knowledge as economic property. Private proprietors strive to maximize profits by re-structuring the business environment through such statutes. According to Jessica Litman with respect to copyright this has got to the point that the “copyright industries... work out the details of the copyright law among themselves, before passing the finished product on to a compliant Congress for enactment” (Litman 1996). In other words, if the intellectual property regime of a nation is the economic constitution of the knowledge-based economy then it is simply too important to be left to proprietors. The regime itself is justified primarily as a reward for creative genius to the benefit of the public. The public domain, which arguably an IPR regime is intended to grow, is a national asset in and of itself, a pearl without price. It is an asset whose value should not be lost in pursuit of private pecuniary profits. The public domain is a good and its growth the reason for intellectual property rights in the first place.

11.6 Qubit IPR

1. Previously I individuated the content of knowledge as the etymological WIT and psychological PSI then socialized the content of knowledge as the epistemological EPI and pedagogic PED. From analysis of ‘rights to know’ in this chapter, a legal Qubit of the content of knowledge can now be deduced, *i.e.*, I will legalize knowledge. The IPR is a qubitic measure of the privatization of knowledge established by law. Intellectual property rights are granted for new knowledge fixed in a material matrix for a limited time. The matrix may be utilitarian as with patents & designs (a Tool); non-utilitarian as with copyrights & trademarks (a Code); or, a person – natural or legal - as with trade secrets and know-how (a Person). All other knowledge (new and old) falls into the public domain.

12.0 ECONOMICS

1. It is in economics, oddly enough, that knowledge as an abstract Platonic noun finds its most explicit expression in the guise of ‘technological change’. Technological change in the Standard Model refers to the effect of new knowledge on the production function of a firm or nation. The content of such new knowledge is not a theoretical concern; only its effects on the production function. As has been demonstrated, however, new knowledge has many sources and varying effects. It may be productive, increasing output on the shop floor; it may be managerial reducing costs or increasing sales; or, it may be entrepreneurial realizing a vision of future markets, products and/or other opportunities. It may flow from the natural and engineering sciences (physical technology), the humanities and social sciences (organizational technology) or the Arts (design technology). In economic theory, however, it does not matter what form new knowledge takes; it does not matter from whence it comes; the only thing that matters, in terms of calculatory rationalism, is its mathematical impact on the production function.

2. In response to technological change, the production function for output may shift upwards or downwards, *i.e.*, technology can be lost as happened with the fall of Rome. The quantity and/or cost per unit output may increase or decrease. Alternatively, an entirely new production function may emerge with innovation of new and/or elimination of old products, processes and techniques. Technological knowledge does not only accumulate; it also withers away if not transmitted to subsequent generations. The latter is most apparent with respect to traditional craft methods (White & Hart 1990). The process has been compared by Kaufmann to speciation and extinction in biology (Kaufman 2000, 216).

3. In the 20th century, technological change became recognized as the most important source of economic growth, *i.e.*, increase in output – absolutely, or, *per capita*. Our understanding of such change, however, remains limited. We do not understand why some things are invented and others are not; why some are successfully innovated and brought to market, and others are not. The contribution of technological change has, in theory, traditionally been treated as a ‘residual’, *i.e.*, after measuring total growth of output, the contribution of an increased quantity and quality of capital, labour and natural resources are factored out and the residual is called technological change. Technological change, in this sense, is a residual amounting to an error term, or, *a measure of our economic ignorance*. In this regard, Kaufmann

criticizes the Standard Model and suggests such ‘ignorance’ can be resolved using the concept of coevolution and coconstruction (Kauffman 2000, 222).

4. Furthermore, in the Standard Model technical knowledge is treated as a public rather than a private good. Thus when new knowledge is published or otherwise made known, others cannot be easily excluded from acquiring it, *i.e.*, it is non-excludable. Furthermore, when shared, the quantity of knowledge is not reduced, *i.e.*, it is non-rivalrous. In fact, the more knowledge is shared, the more knowledge is created. In this sense, knowledge exhibits increasing returns to scale.

5. The effects of technological change in the Standard Model on the production function are conventionally broken out into two dichotomous but complimentary categories: disembodied & embodied; and, endogenous & exogenous technological change.

12.1 Disembodied/Embodied

1. Disembodied technological change has implicitly dominated economic thought since the beginning of the discipline. It refers to generalized improvements in methods and processes as well as enhancement of systemic or facilitating factors such as communications, energy, information and transportation networks. Such change is disembodied in that it is assumed to spread itself out evenly across all existing plant and equipment in all industries and all sectors of the economy.

2. Conceptually embodied technological change traces back to Adam Smith’s treatment of invention as the result of the division of labour (1776). It refers to new knowledge as a primary ingredient in new or improved capital goods. The concept was refined and extended by Marx and Engels (1848) in the 19th and by Joseph Schumpeter in the 20th century with his concept of ‘creative destruction’ (1942). No attempt was made, however, to measure it until the 1950s (Kaldor 1957; Johansen 1959). And it was not until 1962 that the term ‘embodied technological change’ was introduced into the economic lexicon, and by default, disembodied change was recognized (Solow May 1962).

3. The concept of embodied technological change emerged out of the ‘scientific’ research and development (R&D) efforts of the Second World War followed by post-war organized industrial R&D programs. This experience demonstrated that scientific knowledge could be embodied in specific products and processes, *e.g.*, the transistor in the transistor radio. The conceptual development of embodied technological change has, however, “lost its momentum” (Romer 1996, 204). Many theorists, according to Romer, have returned to disembodied

technological change as a *force locomotif* meaning: “Technological change causes economic growth” (Romer 1996, 204).

12.2 Endogenous/Exogenous

1. While embodied/disembodied refers to the form, endogenous and exogenous refers to the source of technological change. Such a distinction is current as the ‘internalist/externalist’ debate in the history, philosophy and sociology of science (Fuller 1992). The source of exogenous technological change is outside the economic process. New knowledge emerges in response to factors such as the curiosity of inventors and pursuit of ‘knowledge-for-knowledge-sake’. In effect, exogenous technological change, from the point of view of the firm or nation, falls from heaven like manna (Scherer 1971, 347).

2. By contrast, endogenous technological change emerges from within the economic process itself - in response to profit and loss. For Marx and Engel, all technological change, including that emanating from the natural sciences, is endogenous. Purity of purpose such as ‘knowledge-for-knowledge-sake’, like religion, was so much opium for the masses cloaking the inexorable teleological forces of capitalist economic development. The term itself, however, was not introduced until 1966 (Lucas 1966) as was the related term ‘endogenous technical change’ (Shell 1966).

3. Endogenous change is evidenced by formal industrial research and development or R&D programs. It therefore includes what are usually minor modification and improvement of existing and new capital plant and equipment called ‘development’ (Rosenberg & Steinmueller 1988, 230). In this way industry continues the late medieval craft tradition of experimentation. R&D varies significantly between firms and industries. At one extreme, a change may be significant for an individual firm but trivial to the economy as a whole. On the other hand, ‘enabling technologies’ such as computers or biotechnology may radically transform both the growth path and the potential of an entire economy. How to sum up the impact on the economy of the endogenous activities of individual firms remains, however, problematic.

4. With respect to the Nation-State, endogenous and exogenous technological change has a different meaning. They refer to whether the source is internal, *i.e.*, produced by domestic private or public enterprise, or external to the nation, *i.e.*, originating with foreign sources.

12.3 New Growth Theory

1. Out of the decades' long debate over embodied vs. disembodied and endogenous vs. exogenous technological change, a new theory emerged in the 1980s called the New Growth Theory. Initiated by Paul Romer (1986), it is explicitly endogenous and implicitly embodied.
2. Like other 'new' forms of economics such as the New Institutionalism (Coase 1992), New Economic History (North & Thomas 1970), New Economic Geography (Krugman 1983; Martin & Sunley 1996) and the New Economics of Science (Dasgupta & David 1994), New Growth Theory appears, at least to this observer, as an exercise in re-calibrating the Standard Model to include descriptive, empirical, institutional and historical evidence previously excluded because of its qualitative rather than quantitative nature.
3. While welcomed, the professional urge remains to fabricate such new evidence into quantitative proxy indicators to be plugged into mathematical models. Romer thus calls for more sophisticated mathematical modeling without expectation of testing because "these kinds of facts tend to be neglected in discussions that focus too narrowly on testing and rejecting models" (Romer 1994, 19-20). So much for Positivism in econometrics!
4. Beyond admitting additional sources of evidence, new growth theory introduces the concept that technological change involves non-rival 'ideas' that can "be stored in a bit string" (Romer 1996, 204), implicitly referring to computer programs, a form of soft-tooled knowledge. His concept, however, presents, to my mind, a confusion between information (measurable) and knowledge (immeasurable) and a failure to acknowledge the distinction between the short-run and long-run with respect to intellectual property, *i.e.*, between knowledge residing in the private domain in the short-run but entering the public domain in the long-run.
5. With respect to information and knowledge, the 'bit' abstracts from content and fails, as has been demonstrated, to provide a homogenous unit measure of knowledge, or what Kenneth Boulding called 'the wit' (Boulding 1966, 2). With respect to intellectual property, in the short-run technical knowledge is rivalrous and excludable to the degree that copyrights, patents and other state-sponsored intellectual property rights provide protection. In the long-run, however, all intellectual property rights expire and knowledge enters the public domain. Given new technical knowledge is continually being copyrighted and patented, one faces an ever moving horizon between rivalrousness and non-rivalrousness, a horizon that can never be reached. Or, put in terms of Lord Keynes' famous aphorism: "In the long run we are all dead" (Keynes 1924).

12.4 Qubit FLX

1. As with most theoretical debates that concerning technological change in economics involves antagonists favouring mutually exclusive positions. To this observer, it appears everybody is right – to one degree or another, at one point in time or another place in space. Technological change can be disembodied in that the production function can be materially affected by systemic changes in facilitating factors such as communications, energy, information processing and transportation. The impact of the ‘B2B’ or business-to-business internet fits this category. In David’s terms, such networks constitute techno-economic regimes predominantly external to the individual firm and/or country (David 1990). Similarly, technological change can be embodied, *e.g.*, the transistor in the transistor radio. It can also be endogenous resulting from the internal R&D programs of firms or exogenous resulting from activities elsewhere in society, *e.g.*, in the universities or elsewhere in the world. In this sense, the production function of a knowledge-based economy rests on the composite effect of disembodied, embodied, endogenous and exogenous technological change.

2. This composite effect can be expressed as an economic Qubit of disembodied, embodied, endogenous, exogenous technological change called a *FLX* (pronounced ‘flex’). I coin the term by recovering a word from Newton’s original but now obsolete *fluxion* meaning “the rate or proportion at which a flowing or varying quantity increases its magnitude” (OED *fluxion*, 5). The modern term is ‘differential’. I also adopt and adapt the term *corresponding fluxion* or “rates at which two interdependent quantities may change simultaneously” to the rates of four quantities, *i.e.*, a Qubit of technological change and its continuous effects on the production function of a firm or nation-state. At any point in time all four forms of technological change are entangled and at work affecting the production function. In this sense, unlike the Standard Model, there is no short-term in a knowledge-based economy during which factors of production are fixed.

3. However, the FLX can be lumpy and uneven. It can also be negative in that ‘de-industrialization’ can occur whereby knowledge moves ‘off-shore’ and is lost to a nation or firm or through ‘de-skilling’ whereby traditional praxis is embodied in a new instrument and similarly lost but this time to a machine. Such a loss of knowledge is analogous to the ‘Kuhnian loss’ in scientific revolutions shifting from one paradigm to another (Fuller 2000).

4. On the one hand, output may be increased or cost reduced; on the other hand, however, there is a loss of knowledge as domestic production is replaced by foreign or advanced machine production. This is one reason for not using the conventional term ‘flow’ which conveys a sense

of constancy. Exogenous changes like innovation of a new general purpose tool may transform the entire economy (David 1990, 335). On the other hand, endogenous tinkering on the shop floor, the ‘D’ or development in ‘R&D’, may only contribute to a specific firm. A FLX is a measure of all four types of technological change or ‘new knowledge’ as it affects the production function of a nation or a firm. Such new knowledge may emerge from the NES as physical technological change, from the HSS as organizational change, from the Arts as design change or some combination thereof. It may also enter the production function in the form of any or all of personal & tacit labour, codified & tooled capital and/or toolable natural resources.

12.5 Anti-Climax: A Theory of Knowledge

1. With economics and qubit FLX, I have completed a six discipline survey of the content of knowledge. In effect, I have individuated (the WIT & PSI), socialized (the EPI & PED), legalized (the IPR) and economized (the FLX) the content of knowledge. There are, of course, other disciplines and sub-disciplines of thought that could contribute ‘knowledge about knowledge’, *e.g.*, anthropology, history, sociology, *etc.* There are also probably concatenations of knowledge other than the qubit that will permit the ideological comparison of knowledge across different domains and disciplines.
2. This chapter also completes my theory of knowledge: the biological human need to know is the *material cause* of knowledge which is pursued through Science by Design as its *efficient cause* generating personal & tacit knowledge as *formal cause* as new memories and/or reflexes, the content of which is the *final cause* of knowledge satisfying a specific need to know.

13.0 THE NATION-STATE

1. If all knowledge is personal & tacit and the Person is the ultimate input and output of a global knowledge-based economy, why did it take until the 21st century for such an economy to emerge? Arguably, it is because humanity, like Science by Design, is dyadic. Each of us is a “social solitaire” (Bronowski 1973), *i.e.*, simultaneously a psychological and sociological being. In Kaufmann’s terms, psychological and sociological developments coevolve. Like a Kantian organism, each part mutually determines growth and development of the other. In historical terms, the natural Person is, in fact, a recent arrival linked with emergence of both the experimental sciences and the modern Nation-State. In introduction, I will briefly examine the emergence of the natural Person and its relationship to the modern Nation-State.
2. It was only in the 15th century that the ‘individual’ Person, as Renaissance artist/engineer/humanist/scientist, began to rise above ancient and medieval subordination by birth. In the 16th century, the Protestant Reformation or revolution recognized an individual’s direct link to a personal God rather than depending on intercession by Church, Pope, saint or priest. With the scientific revolution of the 17th century, Nature began to reveal her secrets at the hands of the individual, isolated scientist using the experimental method, not Scripture nor the works of the Ancients. With the republican revolution of the late 18th century, the ideological and legal foundation of the natural Person was laid. It was not, however, until the industrial revolution of the 19th century that the human species escaped its near total dependence on natural power sources, especially human muscle. With this development there began an accelerating division and specialization of knowledge.
3. While revolution prepared the path, it took World War I and the military might of a republican United States for the term ‘Nation-State’ to enter the language and for the republican ideal of “We, the People” to become a global norm. Nonetheless, it still took the pain and suffering of the Great Depression for the liberal democracies to assume responsibility for national or macroeconomic policy guided by Keynes’s *General Theory* (Keynes 1936). And it was only with the collapse of the Soviet Union in 1989 and creation of the WTO in 1995 that a truly global economy, including knowledge as a tradable commodity, emerged.
4. In a way, the Communist Revolution was a seventy-five year detour on a nearly five hundred year republican road leading to the progressive individuation of the individual, *i.e.*, of

the natural Person. Compared to the taste-driven consumer of the republican revolution, the ‘new socialist man’ of the communist revolution was not so much an individual or a Person but rather a replaceable part or component of a transcendent collective. Power exercised by the leading vanguard of the revolution, the Party, flowed down from the top, not up from the bottom.

5. If the natural Person is both ultimate input and output of a knowledge-based economy, then the Nation-State is the foundation upon which Persons collectively stand as ‘We, the People’ and, in fact, of the knowledge-based economy itself. In this chapter I will first examine the nature and history of the Nation-State and the shifting sands of sovereignty upon which it stands. I will then sketch out alternative modalities of governance of the national knowledge-base.

13.1 Origins

1. What is a Nation-State? First, there are many kinds of nations. Some are folk- or language-based such as Germany, Japan and various ‘nations’ of aboriginal peoples around the world. Some are based on religion like the Nation of Islam and Christendom. Some are geographical entities resulting from colonial expansion of Western European nations during the last five centuries, *e.g.* Australia, Canada, Ghana, Indonesia, South Africa and the United States. Such post-colonial ‘territorial’ nations have, in some cases, become stable and prosper; others remain unstable due, among other things, to arbitrary colonial splitting and mixing of pre-colonial tribal and/or folk nations.

2. Some are ‘Nation-States’ a word that did not enter American English until 1918 (MWO, *nation-state*, n). The OED, however, reports this as its second entry: “the ultimate genesis of the world conflict of to-day is sought... in... the existing European polity... based upon the recognition of the rights of a large number of Nation-States, entirely independent and nominally coequal.” The first OED citation, however, is in 1895: “the Teutons, the architects par excellence of the nation-state” (OED, *nation-state*, n). The disintegration of continental European empires built up over centuries – Austro-Hungarian, German and Russian – into sovereign Nation-States based on ethnicity and language – was the geo-political triumph of the Treaty of Versailles that ended WWI. It was the vision of President Woodrow Wilson of the Republic of the United States of America. Governance was increasingly exercised in the name of “We, the People”, not of the Crown or Cross. In this regard, the word ‘nation’ derives from 12th century Anglo-Norman meaning “‘a people united by common language and culture’, and ‘family, lineage’” (OED, *nation*, n 1, Epistemology). It is this sharing of language, culture,

geography, history and/or religion that coalesce into ‘national identity’, *i.e.*, of being a people separate and distinct from others.

3. While the aspirations and competitiveness of folk nations subsumed within the borders of existing Nation-States can be intense and materially affect the well-being of their host, *e.g.* the IRA in the United Kingdom, the FLQ in Canada and ETA in Spain, such competitiveness is not my focus. Nor is the struggle of Al Qaeda to establish a global Islamic caliphate directly relevant. Furthermore, in this chapter, I will not consider trans-national epistemic communities like the Republic of Science (M. Polanyi 1962b). Rather my attention concentrates on the Nation-State. I will make only passing reference to other types of nations.

4. While the term ‘Nation-State’ is less than one hundred years old, it has become locked in as the dominant form of nationhood today. Only Nation-States can be members of the United Nations (UN) and, with the historical exception of Hong Kong, the same is true of the World Trade Organization (WTO) as well as various international agencies such as copyright and patent unions. Only Nation-States can sign diplomatically binding treaties. Among the current 189 members of the UN some are vast continental Nation-States like Australia, Canada, China, Russia and the United States. Others are geographically tiny like Andorra, East Timor, Monaco and San Marino. Some have populations in the billions, like China and India. Others count citizens in the tens of thousands or less.

13.2 Shifting Sands of Sovereignty

1. Quoting John Stuart Mill in 1860, the OED defines sovereignty as “supreme controlling power”. For our purposes, this refers to a territorial entity called a Nation-State (OED, *sovereignty*, 3 b). Since his time, however, the *de facto*, if not *de jure*, definition has changed dramatically. Thus, some one hundred and thirty years later, Mill’s compatriot, Sir Leon Brittain expressed the contemporary concept of sovereignty just as the last Stalinist state in Europe was about to fall.

A man standing alone and naked in a desert is sovereign. He cannot be influenced by anyone or any power. Yet he is impotent. He is, if you like, in Albania. Sovereignty means nothing unless it represents the ability to control our destiny. And in the modern world, that means forming alliances and pooling influence. (Brittain 1989)

2. Sovereignty, however, involves more than alliances and pooling influence. I will examine sovereignty with respect to five dimensions: biological, cultural, ideological, military and political economic.

13.2.1 Biological Sovereignty

1. In many ways, a Nation-State is like a biological organism. First, like a cell it has a semi-permeable membrane called borders that separate it from an environment populated by other Nation-States and common or shared resources like the oceans, seas and outer space. It is in competition, and sometimes conflict, with its neighbours for control of such resources. Osmotic forces are also at work across such borders. There is thus a tendency for high concentrations on one side, *e.g.*, American entertainment programming, to seep across cell walls into another, *e.g.*, Canada. Second, like a multi-celled, multi-organelled animal, the Nation-State has institutions that: (i) centrally govern and regulate its activities like the nucleus of a cell or brain (national government); fuel its activities like mitochondria in a cell (energy industry); defends against invaders and rogue elements like the immune system (military and police); and, erects and maintains infrastructure like DNA-induced proteins building and maintaining its structure (construction industry).

2. Third, Nation-States coevolve and specialize filling ecological or 'market' niches like the organs of an animal. Furthermore, the competitiveness of nations is dynamic, *i.e.*, it changes and mutates over time. It exhibits emergent evolution, *i.e.*, "the appearance of new characters and qualities at complex levels of organization (as the cell or organism) which cannot be predicted solely from the study of less complex levels" (MWO, *emergent evolution*, n).

3. Fourth, using Kaufmann's definition of a biosphere, a Nation-State can be seen as a "... a self-consistent coevolutionary construction of autonomous agents making livings, the natural games that constitute those livings, and the search mechanisms that allow such modes of living to be persistently mastered by adaptive natural selection" (Kaufmann 2000, 75).

13.2.2 Cultural Sovereignty

1. In July 1947, *Foreign Affairs* published an anonymous article signed "X" entitled "The Sources of Soviet Conduct." It proposed what became the foundation of U.S. policy towards the Soviet Union and Communism in general – containment. This policy endured through a fifty year global Cold War, or the Third World War. The author was soon revealed to be George Kennan (1947).

2. With the fall of the Berlin Wall and the end of the Soviet Union, a new post-modern era began. Almost immediately, a search started for the pattern of this new and unexpected era. One scholar, Samuel Huntington, penned what may be the "X-article" for the post-Cold War era – "The Clash of Civilizations?" ([Huntington 1993](#)). Huntington argues that global conflict based

on ideology has been replaced by the clash of cultures. He suggests it will be where the “tectonic plates” of different cultures – language, religion and race – meet that conflicts will erupt. He identifies eight major ‘civilization identities’: Western, Confucian, Japanese, Islamic, Hindu, Slavic-Orthodox, Latin American and African. The chaos in the Balkans during the 1990s, where Catholic Croat, Orthodox Serb and Moslem Bosnian (all Southern Slavs sharing the same Serbo-Croatian language) were at each others throats, lends weight to his premise that any major cultural difference can lead to collective violence and ‘ethnic cleansing’.

3. Arguably the ‘global war on terror’ beginning with the September 11th, 2001 attack on the World Trade Center constitutes a Fourth World War in Huntington’s clash of civilizations. In many ways, *Al Qaeda* is a classic emergent social process identified by Emery and Trist (1972, 24) – starting small and parasitically it attached itself to the Islamic government of the Sudan and then to Taliban Afghanistan growing in their shadow until strong enough to challenge and survive, in the case of the Taliban, the host itself.

4. Yet more subtle and simmering differences and disputes, long suppressed by allies and adversaries in a coordinated bi-polar global Cold War are re-surfacing after fifty years of quiescence. Such differences can be summed up as the struggle for ‘cultural sovereignty’. By 1989 this term was current in Canada having been introduced into the public policy lexicon in the 1970s during the struggle for Quebec independence. Globally, however, cultural sovereignty involves the struggle to be heard at home and abroad above the booming voice of the American entertainment industry. The one remaining superpower is also a global cultural colossus spanning East, West, North and South.

5. In this struggle one side argues that national and regional identity is based upon a distinct set of values embodied in cultural goods and services. Even in the United States, some are raising this argument as foreign interests acquire American cultural enterprise, *e.g.*, Hollywood studios and Rockefeller Center in New York. The other side argues the universality of human values. This global village argument contends that experiences shared on a global scale through communications media transcend differences among citizens of separate nations or regions. Some observers suggest this vision is becoming a reality and point to developments in the former Soviet Union, Eastern Europe and China as responses to values of freedom, dignity and prosperity transmitted through penetrating networks of global mass media and communications.

6. The battle for cultural sovereignty, however, is not just defensive. For example, Canada, France and Sweden lead an international alliance fighting to maintain cultural exemptions under

GATT and, if possible, extend them ([Chartrand 2002](#)). Similarly, most Nation-States including Canada are engaged in developing commercially viable national cultural industries of their own. In practical terms, this means cultural products that sell in the American marketplace and therefore sell anywhere. At worst, this policy fosters cultural clones of American entertainment programming. Such attempts generally involve international film, television and musical recording agreements to share production costs and the billing of stars from co-operating Nation-States ([Acheson & Maule 1994, 2002](#)).

7. There are also ongoing efforts to establish the 'Brand State'. Through organized advertising campaigns, Nation-States strive to create a positive image in the minds of foreigners. Singapore and the Republic of Ireland are examples that have successfully created an emotional resonance with other peoples (van Ham 2001). On the one hand, the Brand State reflects the importance of tourism as the largest industry in the world. A quality brand, however, also lubricates the sale of other goods and services on world markets. On the other hand, contemporary branding is arguably just an extension of ancient historiography practiced by royal dynasties in medieval and Renaissance western European history. National historiography, the origins of nations, differ between the Nations States that coalesced into modern Europe out of the Germanic occupation of the Western Empire ([Chartrand 1992a](#)). In France, it was the *Chanson de Roland* telling tales of glory about Charlemagne's champion stopping the Islamic invasion of Western Europe. In England, it was the Arthurian legend and the Holy Grail used to support the Tudors and the Anglican Church (MacDougall 1982).

8. Another emergent cultural process laden with significance for the competitiveness of nations is global urbanization. The world has experienced unprecedented urban growth in recent decades. In 2000, about 47 percent of the world's population lived in urban areas (about 2.8 billion people). There were 411 cities over 1 million. In the more developed Nation-States about 76 percent of the population lived in urban areas, while 40 percent in less developed countries. However, urbanization is occurring more rapidly in less developed countries and it is expected that 60 percent of the world's population will be urban by 2030 (Population Division, 2002). A global society where there is virtually contiguous urban development separated only by natural barriers is called the 'Ecumenopolis' by urban designer Constantinos Doxiadis (1976, 327). This global reality is strikingly portrayed in a composite photograph of "[The World at Night](#)" published by the NASA (November 27, 2000).

9. In this regard, arguably another new “X article” has been penned by Robert Kaplan: “The Coming Anarchy”. Kaplan argues that national security in the sense of defending borders is outdated (Kaplan 1994). He argues few live in the countryside any more. Borders are now simply lines on a map. Everyone lives in cities. For the first time in human history, the majority is, or shortly will be, “civilized”. However, it is in the cities that tribes of barbarians – old and new – are gathering; tribes that pose, according to Kaplan, the real threat to 21st century national security. Whether it is street gangs in south Los Angeles, St. James Town in Toronto or Mogadishu in Somalia or Al Qaeda cells in major cities around the world, low grade urban conflict threatens the sovereignty and security of the post-modern Nation-State. Furthermore, given urban innovation clusters are the foundation stone of a national innovation system (OECD 1997), urban unrest has implications for the competitiveness of nations.

13.2.3 Ideological Sovereignty

1. Beyond geographic size, population and culture, Nation-States can also be classified according to ideological development. From a Cold War past we have inherited a global village with four neighborhoods – the First, Second, Third and Fourth Worlds.

2. The First World includes member countries of the Organization for Economic Cooperation and Development (OECD). These are advanced industrialized countries with well-developed market economies enjoying political democracy. They also have well developed legal systems as well as customs and institutions supportive of a self-regulating market.

3. The Second World includes countries of the former Communist Bloc which, until the collapse of the Soviet Union, formed a body corporate parallel to the OECD and to the GATT called the Council for Mutual Economic Assistance (COMECON). They had one-party politics and command economies using ‘material balances’ rather than market prices. With the breakup of the Soviet Union many adopted, to one degree or another, democracy and market economics, *i.e.*, the last ideology standing. Only North Korea and Cuba maintain command economies. China, and more recently Vietnam, by contrast, retain a communist monopoly of political power but have adopted a market economy. Markets truly have triumphed over Marx. Nonetheless, the Second World still exists. It has relatively high levels of education and advanced technology in selected sectors, particularly defense. It also has underdeveloped democratic, legal and market institutions and customs. They have also inherited, by First World standards, antiquated public infrastructure including communications, environmental and transportation systems.

4. The Third World includes the formerly nonaligned Nation-States especially countries of the “South”, *i.e.* the southern hemisphere. They are politically diverse. Some are political democracies with market economies; some are authoritarian; some are ruled by military regimes. Third World economies in the 20th century depended on natural resources and cheap labour to compete in world markets. In the 21st century this is changing with India now leading the way.

5. Finally, there is the Fourth World, which, unlike the previous three, is not made up of Nation-States. Rather it includes native or aboriginal nations of the Old and New Worlds. They live in northern Europe, *i.e.* the Lapp or Suomi people; in Asia, the so-called tribal or nomadic peoples (Stackhouse 1994); in Africa, *e.g.*, the pigmy peoples; in Australia, the “Aborigines”; and, in both North and South America, the Amerindian peoples or ‘First Nations’ sometimes including mixed blood communities such as the Metis peoples of Canada. Essentially, they have been dispossessed by colonization and/or modernization. They have also begun to organize at the global level, *e.g.*, the *International Covenant on the Rights of Indigenous Nations* initialed July 28, 1994 in Geneva, Switzerland ([Centre for World Indigenous Studies](#) 1994). They are also struggling to protect their rights to ‘traditional ecological knowledge’ or TEK. Do traditional and/or Fourth World peoples have property rights to the herbs, medicines and foods that they have cultivated and cross-breed for generations? Under both Anglo-American Common Law and European Civil Code such rights belong only to a Person, natural or legal, and are in effect only for a limited numbers of years, not as long as the rain falls and the wind blows. In many ways this legal battle places collective versus individual rights at the centre of the knowledge-based economy

13.2.4 Military Sovereignty

1. Beyond geography, population, culture and ideological status, Nation-States can also be classified according to military power or potential. Today there are three great powers in the military sense – China, Russia and the United States. Of these the United States is a superpower with global military reach. Beneath the great powers are middle powers such as France, India and the United Kingdom then regional powers like Brazil, Indonesia and Iran. Two Nation-States are potential great powers – Germany and Japan – but they function under constitutional limitations imposed by the victors of the Second World War.

2. Traditionally the competitiveness of nations reflected the ability (or potential) of a nation to engage in military conflict with other nations and impose its will upon them, or defend

itself against them. The 20th century witnessed many examples including two hot world wars, one cold, together with the rise and fall of empires – aristocratic, colonial, communist, fascist and national socialist – all through the force of arms. The current 21st century global war on terror is similarly galvanizing Nation-States in defense against yet another transnational ideology. This one, however, is rooted in religion aiming at a global Islamic caliphate working from within a Nation-State's borders, not from without, *cum* Kaplan. Some sacrifice of privacy and other human rights in the name of wartime is part of the price paid. As will be demonstrated in more detail below, it is, however, a price that Bertrand de Jouvenel sees as part of a much larger trend towards increasing intrusion of the State into the personal lives of citizens.

3. The current conflict, however, highlights a critical characteristic of the global knowledge-based economy, *i.e.*, it is a crazy quilt of overlapping temporal gestalten (Emery & Trist 1972, 24). Some nations are effectively living in the 6th century of the common era while others function in the fifteenth century of the Islamic calendar and yet others inhabit a 21st century world where there is but one planet, one biosphere and one human race seen from the vantage point of space.

4. While the economy provides the wealth to exercise military power, success is historically in the hands of leaders who make the most of what they have. Thus an Alexander the Great made a small marginalized part of ancient Greece (Macedonia) the greatest power in the world. Similarly, Genghis Khan took tribes of nomads whose economic strength was negligible and converted them into an empire stretching from the Pacific Ocean to the gates of Warsaw. Thus while economic strength may serve as the foundation for military power it has not always, is not now (*e.g.*, North Korea and Iran) and may not in future be the case. Put another way, new military knowledge can quickly change the balance of power and such new knowledge need not be the product of economic strength.

5. The great events of the 20th century involved formation of shifting military alliances each of which, by definition, compromised sovereignty, *e.g.*, NATO and the Warsaw Pact. Nonetheless two global attempts were made to establish a forum to avoid and/or settle military and political disputes between Nation-States without resort to arms. These were the League of Nations after WWI and the United Nations after WWII. In effect, the family of Nation-States agreed to resolve their conflicts through the United Nations. While not totally effective, arguably the UN played a pivotal role in keeping the Cold War 'cold' until its end in 1989. In the process, however, military sovereignty was significantly compromised and the degrees of freedom available to a Nation-State reduced.

13.2.5 Political Economic Sovereignty

1. In 1944 Karl Polanyi, brother of the chemist and philosopher of science, Michael Polanyi, published the first edition of *The Great Transformation*. According to some scholars this book is of renewed relevance in a post-Cold War world due to the emergence of a global knowledge-based economy (Block 2001; Munck 2002).

2. Polanyi traces the evolution of the market from its prehistoric roots to *The Great Transformation* of the 19th century. Until then the market was, Polanyi contends, embedded in and subordinate to the social system. In Western Europe, this embedding was evidenced by charters and patents granted by monarchs to guilds, municipal corporations, trading companies, universities and other bodies corporate. Arguably the first break in this system was the 1624 *Statute of Monopolies* which, in England, ended royal grants of industrial privilege with the notable exception of patents of invention and copyrights. This marked the beginning of the *laissez faire* economy, *i.e.*, let producers produce what they want, not what the Crown wants. The final break was arguably abrogation in 1814 of the *Statute of Artificers* that ended guild control of the labour market and signaled the beginning of a *laissez passer* economy, *i.e.*, let workers move to where they can find work. With the 18th century Republican Revolutions, the underlying political system of subordination also slowly gave way before popular democracy in the form of a republic or constitutional monarchy.

3. While markets have always existed as places or networks where goods are bought and sold, the new free or self-regulating market was society-wide. Both outputs and inputs including capital, labour and natural resources went up for sale. State involvement in the economy was minimized according to selectively interpreted principles articulated in Adam Smith's 1776 *The Wealth of Nations*. These were, however, most succinctly expressed by Smith's contemporaries, the French Physiocrats as *laissez faire* and *laissez passer*. In this regard, "Polanyi is insistent that 'laissez-faire was planned; planning was not'" (Block 2001, 12). It is ironic that the Republican Revolutions that gave birth to modern political democracy based on the inalienable 'rights of man' coincidentally converted human beings and nature into marketable commodities.

4. For Polanyi, "the definition of a commodity is something that has been produced for sale on a market" (Block 2001, 9). By this definition, labour and natural resources are 'fictitious' commodities because they were not originally produced to be sold on a market. The Standard Model assumes, however, that such inputs behave like 'real' commodities.

5. To Polanyi, this assumption is false and places human society at risk. It is false for two reasons. First, it "violates the principles that have governed societies for centuries: nature and

human life have almost always been recognized as having a sacred dimension” (Block 2001, 9). According to Polanyi, it is impossible to reconcile this sacred dimension with the subordination of labor and nature to market price. Second, while the economy is supposedly self-regulating, the State actually plays an inevitable role in, for example, control of the money supply as well as managing education, unemployment, training and a host of other policies that effectively, even if unnoticed, regulate the marketplace (Block 2001, 9-10). This contradiction of market liberalism is evident with respect to intellectual property rights. Knowledge, by its nature, is not a private good yet government fiat converts it into a legally enforceable monopoly.

6. On the one hand, the self-regulating market displays a remarkable efficiency of knowledge especially compared to centrally planned material balances as practiced by the failed Marxist command economies. The knowledge efficiency of the price system was central to the work of one of Polanyi’s archrivals, Fredrick von Hayek (Hayek 1937, 1945, 1989). On the other hand, the self-regulating market places costs associated with economic downturns on the atomized individual rather than on the guild, corporation, community or government. The resulting stress on business as well individuals, according to Polanyi, produces an inevitable political countermovement to regulate the supposedly self-regulating market economy. Taken together – movement towards the self-regulating market and movement towards its regulation – represent what is called the ‘double movement’ of Polanyi’s *Great Transformation* (Munck 2002, 17).

7. For Polanyi, this double movement can only be resolved by the eventual disappearance of the self-regulating market to be replaced by some form of socialism. Like Marx, he was wrong with respect to the end state (as of today) as demonstrated by membership of the communist People’s Republic of China in the WTO. In law, the self-regulating market now rules a world no longer split between capitalist and socialist blocs. Like Marx about alienation, however, Polanyi appears correct in that counter-movements to globalization have arisen (Munck 2002). I can identify three. Before examining them, however, I must establish what I call ‘Phase II’ of *The Great Transformation*.

8. As previously noted, the success of the self-regulating market rests on the inherent knowledge efficiency of the price system. This has been amplified to levels unthinkable by Karl Polanyi or von Hayek in the 1930s and ’40s. In the 1970s, a global electronic payments system emerged spinning a transactional web over all market-based economies and subsequently all Nation-States with the exception of North Korea and Cuba. Visa, Mastercard and American Express are everywhere. The technological ability to collect, compile and process transactional data on a global scale marks what I call Phase II of *The Great Transformation*. What must be

appreciated is that Polanyi and Hayek agree that there is something happening above the range of conscious human control, *i.e.*, the self-regulating market (Polanyi) and the price system (Hayek). In this regard, Václav Havel has suggested that what the West did not appreciate was that the fall of Communism was marked the end of the Age of Reason, *i.e.*, in the belief that the economy could be rationally planned and centrally controlled. This belief has surrendered to a belief in a transcendent function - the market - over which, ideally, no economic agent exercises market power and in which the 'invisible hand' produces the greatest good for the greatest number (Havel 1992). The ideological foundation of this belief is, of course, the Standard Model of economics.

9. Phase II succeeded, however, because of an institutional matrix created after the Second World War and designed by another of Polanyi's rivals, John Maynard Keynes. The Bretton Woods Conference of July 1944 planted the roots for a global monetary order designed to escape the damaging effects of the Gold Standard that both Polanyi and Keynes believed doomed the pre-war global market. Out of this conference came the International Bank for Reconstruction and Development (later divided into the World Bank and Bank for International Settlements) and the International Monetary Fund. Within four years, the General Agreement on Tariffs and Trade (GATT) came into effect (January 1, 1948). In turn, GATT gave birth to the WTO in 1995 marking the arrival of a truly global self-regulating market governed by international law. Thus, on the one hand, the self-regulating market has become formally embedded in the law of nations, or more precisely, the law of Nation-States. On the other hand, economic sovereignty and the ability to set national policies have been compromised to gain admission to the global marketplace.

10. With respect to counter-movements to the global marketplace, the first, and most obvious, is the non-governmental anti-globalization movement around the world. In effect, it rejects embedding society within the economy. Put another way, one should work to live, not live to work and anti-globalization forces do not want the tail to wag the dog.

11. The second is the New Regionalism in international studies (Spindler 2002). According to this school of thought, business is responding to globalization by reshaping the regional geopolitical landscape, *e.g.*, NAFTA, to allow a more efficient and effective embedding of business in a reconstituted political economic matrix. Polanyi argued, of course, that the political system (and society as a whole) is being embedded in the economy.

12. The New Regionalism also raises the question of whether such regionalization is a stepping stone or stumbling block to globalization. The question must, I argue, be addressed

with respect to the ideology of the market, *i.e.*, the Standard Model of economics. This claims that the market works best without political interference. It is on this basis that if the WTO finds in its ‘courts’ that a member state has interfered then countervail is authorized. That surreptitious efforts are constantly being made to subvert the market is clear - banana wars, steel wars, BSE bans, GM restrictions, *et al.* Nonetheless, the ideal is equally - Let the market do it’. This is the ideological bench mark against which the global market behaviour of Nation-States is judged.

13. Regionalization is, to my mind, a stepping stone towards a global economy so long as the ideology of the market remains the bench mark, *e.g.*, in NAFTA and the EU. Of course, similar surreptitious attempts to intervene occur at the regional level, *e.g.*, the ongoing softwood lumber controversy between Canada and the United States. However, to the degree that these attempts are subject to countervail then the direction remains clear: towards a self-regulating market.

14. The third counter-movement to globalization is the internal growth of government itself. Bertrand de Jouvenal, in his 1949 *Power: Its History and the Nature of Its Growth*, demonstrates the process whereby the power of the Nation-State has grown from the time of the Absolute Monarchs of the 17th and 18th centuries. This process he characterizes as the increasing penetration of the State into the daily life of its citizens and the growing sophistication of its organization to enhance internal sovereignty. He documents the resulting increase in the scale and damage of warfare up to WWII. He also notes that traditional inhibitions on state power resulting from its embodiment in the person of a Monarch disappeared with the arrival of popular democracy (Jouvenal 1949, 8-9).

15. De Jouvenal notes how in the name of ‘the Nation’ or ‘the People’, modern government can do things which a supposedly Absolute Monarch dared not dream. This is summed up in the Second World War concept of ‘Total War’, *i.e.*, the use of all available national resources – physical, institutional and individual – to wage war. Before the Republican Revolutions, Total War was simply not possible (Jouvenal 1949, 8).

16. De Jouvenal exposes the equation of power, or what he calls “the Minotaur” of popular democracy. For Marx there is struggle between Top (the rich) and Bottom (the poor) leading to revolution. De Jouvenal, however, argues the struggle is between the Top (the State) in alliance with the Bottom (the oppressed) squeezing the Middle (the Establishment) and progressively penetrating ever deeper into the personal lives of citizens. As a new Bottom is recognized, the Middle is squeezed again and again so that State Power perpetually grows.

17. Arguably, De Jouvenal's power equation is demonstrated by the sequential rise of the labour, civil rights, women's and children's movements. The dynamic involves:

- labour allying itself with government to regulate the behaviour of 'Robber Barons' beginning with abolition of conspiracies acts against unions in the 1880s;
- blacks and other visible minorities allying themselves with government to regulate 'white' behaviour beginning with the mid-1960s Civil Rights Movement;
- women allying themselves with the State to regulate the behaviour of men in the 1970s Feminist Movement; and,
- children allying themselves with the State in the 1990s to regulate the behaviour of parents and adults including international efforts against 'kiddie porn'.

18. There are, however, different ways for state power to grow, ways that may not be publicly visible or apparent. In a comparative analysis of the constitutions of the United Kingdom, the United States, France, Germany and Austria, three British constitutional lawyers conclude their findings in their title: *Government by Moonlight: The Hybrid Parts of the State* (Birkinshaw, Harden and Lewis 1990).

19. While Lord Keynes is best remembered for rules governing the ship of State in the economic ocean, the authors remind us that he also foresaw the growth of semiautonomous bodies associated with the State which, like dolphins swimming ahead, lead the way towards the public good. In this regard, Keynes was father to the Arts Council of Great Britain, a postwar institution funded by the State but operating at arm's length from its political direction (Chartrand & McCaughey 1986).

20. Written just after Margaret Thatcher had left the political stage and as the Soviet Union collapsed, the authors argue that contrary to orthodox Thatcherism and its North American variants, the ship of State is not returning to some mythic free market port with a crisply defined coastline separating public policy from a mainland of private self-interest. Rather, in keeping with Keynes's prescience, semiautonomous bodies have become vessels in a public/private convoy used to 'offload' responsibilities accumulated by the ship of State during the rising tide of the postwar Welfare State or now required in a post-modern era. The course of the ship, however, remains unchanged – increased State control.

21. From the constitution emerging after the English Civil War of the mid-1600s to the republican revolutions of the 18th century, first American and then French, the authors argue there has been a progressive constitutional co-optation of private interest in pursuit of the public good. The most evolved examples are the post-WWII constitutions of Austria and Germany that

make explicit provision for the accountability of private interests serving the public good. Concentrating on the least formalized, the ‘unwritten’ constitution of the United Kingdom, the authors demonstrate off-loading ranges far and wide – from accounting standards, financial markets, industrial strategy, land-use planning, labour relations, national defense, professional self-regulation, R&D as well as art, education, health, housing, voluntarism and welfare.

22. This restructuring has been necessitated by the inherent complexity of modern life, the limits of rationality resulting from imperfect information and a turbulent policy environment. This fuels a *perestroika* as fundamental, if not as apparent, as that which shattered the Soviet Union. The authors argue that through bargaining, cooptation and threat of legislation, the State has effectively transferred various public responsibilities to a spectrum of public/private institutions. It has done so to reduce costs, increase effectiveness and simplify its policy environment.

23. The authors use a body of literature about ‘corporatism’ to define this restructuring in terms of stable bargaining relationships between associations of private interest like the defense industry and the State. They point out that corporatism is not necessarily incompatible with, but rather potentially complimentary to, traditional geographic-based constituency democracy. While the author’s suggest ‘tripartism’, *i.e.* government, management and labour cooperation, is *passé*, an ironic legacy of Thatcherism and its legislative imposition of the secret ballot on unions in the U.K. is potentially the re-democratization of the union movement – a step towards realizing Sydney and Beatrice Webbs’ dream of industrial democracy.

24. But public authority exercised by private interests raises questions of accountability. With the exception of the post-war Austrian and German constitutions, there has been no equivalent *glasnost* or openness. Various factors conspire to obscure, at least in Britain, the exercise of public authority by private interests. These include free market rhetoric, failure to develop a body of administrative law comparable to that on the Continent or even in the United States and a self-serving conspiracy of silence between the State and recipients of public authority. Ministerial accountability, while arguably no longer functional, is also a powerful incantation in a parliamentary democracy and has blinded citizens to the changing nature of their democracy.

25. The authors present a range of accountability regimes to make the new public/private partnerships transparent to public scrutiny. In this regard, they define ‘constitutional’ in procedural terms such as participation by citizens in open and informed debate about the objectives, policies and procedures of public policymaking. They call not only for freedom of

information but also creation of intermediating institutions to process information into forms accessible to the public. This would represent a significant increase in the size of the public domain and hence the national knowledge-base. In the process it would foster what I call 'information democracy'.

26. A recent example in Canada highlights the accountability problem associated with hybrid parts of the State. In March 2001 the Canadian Institutes of Health Research (CIHR) announced preliminary guidelines for stem cell research (a culturally and political controversial issue) due to the failure of Parliament to do so. In April 2002 a political outcry was heard in Parliament when the CIHR was about to fund research according to these guidelines (Laghi Apr. 30, 2002, A1).

13.3 Reconciliation

1. In summary, sovereignty as "supreme controlling power" over the territory of a Nation-State is a myth with a twist. Many, if not a majority, of members of the United Nations do not exercise military sovereignty over their territory but rather share it in alliance with other Nation-States. In effect, with the exception of the great, middle and regional powers, the defense of the Nation-State is in the hands of the United Nations itself. The UN, as an organization, however, is dedicated to maintaining existing borders and the integrity of member states even if such borders and states are the collateral damage of the 19th century struggle for European colonial empires.

2. If military sovereignty has been compromised then economic sovereignty has similarly been eroded by membership in the WTO which defines the rules for a global self-regulating market economy in which arbitrary actions in one's national self-interest carries with it the threat of countervailing measures authorized by the WTO. Cultural sovereignty, on the other hand, remains an arena in which sovereignty is still exercised under the protection of exemptions granted by the original 1948 GATT agreement. Cultural quotas, subsidies and other barriers to trade are currently accepted as the prerogative of the sovereign Nation-State. Arguably, IPRs are another arena of competition subject only to the 'national treatment' provisions of the TRIPS Agreement. Similarly, health and safety have become arenas in which sovereignty remains intact, witness the closing of borders to Canadian and American beef exports after the discovery of one case of BSE in Canada and one in the United States. Unlike cultural sovereignty and IPRs, however, such health and safety barriers must be justified on scientific, not moral, cultural or historical grounds.

13.4 Governance

1. In the Standard Model of economics there is no role for government. Under conditions of perfect competition all costs are internalized by producers into the market price. There are no uncosted externalities like pollution. In turn, the consumer paying the market price internalizes all benefits. There are no external benefits as with a public good. There are, in fact, no costs or benefits external to the market transaction. There is, therefore, no need for government in the economy. Ironically, the Standard Model shares this conclusion with Marxism. Under conditions of perfect communism there will be a 'withering away of the State'. In Leninist terms, there will be no role for the Party as a revolutionary vanguard because the revolution would have happened.
2. In a knowledge-based economy, however, government is not a necessary evil that will eventually disappear. Rather it is a positive necessity for such an economy to exist. This is most evident with respect to the privatization of new knowledge through legislated intellectual property rights. Government plays, however, at one and the same time, five different roles: as Custodian, Facilitator, Patron, Architect and Engineer of the national knowledge-base.

13.4.1 Custodian

1. The Custodial State is directly responsible for access to and conservation of the national knowledge-base, *i.e.*, the public and private domains of knowledge. This is evidenced by institutions like national archives, museums, libraries and arts centres. It is also evidenced by cultural patrimony legislation controlling the export of national treasures and by departments of government mandated to protect, preserve and promote national culture, *e.g.*, Heritage Canada or, in French, *Patrimoine Canada*. Through intellectual property legislation, government is also responsible for the preservation and extension of the public domain or national knowledge-base.

13.4.2 Facilitator

1. The Facilitator State supports production and conservation of knowledge through tax expenditures, *i.e.* taxes foregone or forgiven. Government can choose not to tax certain types of income and/or expenditures made by citizens because relevant activities are considered merit goods. A merit good is one whose consumption or production is encouraged on the basis of non-market value judgments. It is the opposite of a *demerit* good or service, *e.g.* smoking or, at the extreme, crime. As with public goods, of which merit goods are a subset, the private market cannot profitably provide the quantity or quality government requires. A charitable donation

made by an individual or an organization is an example of tax expenditure. In this case government mandates that a donation to a recognized charity should, in whole or in part, be subtracted from income tax due to the government. Donations in support of the nonprofit arts (Arts), education (HSS) and scientific (NES) research including medical research (Practices) are knowledge-based examples as are donations to religious (Revelation) and sports (Sensation) institutions. To the degree a charitable organization is engaged in knowledge production it is relevant to a knowledge-based economy. Exemption from income tax of copyright income earned by resident artists, *i.e.*, natural Persons, in the Republic of Ireland (Eire) is an example relevant to all knowledge domains.

2. The Facilitator supports diversity rather than specific knowledge domains or disciplines. Specific standards are not established by the State because the Facilitator relies on the preferences and tastes of corporate, foundation and individual donors. The policy dynamic is random in that tax expenditures reflect the changing tastes of private donors. The United States has traditionally relied most heavily on facilitating private giving rather than direct public spending as, for example, in most western European states. Arguably, however, a convergence of funding patterns is emerging on both sides of the Atlantic ([Chartrand 2002](#)).

3. The strength of the Facilitator lies in the diversity of funding sources. Individuals, corporations and foundations choose which knowledge domains and disciplines to support. The Facilitator also has weaknesses. First, once tax exempt status is granted, standards of excellence are not required. Second, the State cannot easily target priority activities. Third, valuation of donations-in-kind, a common practice in the Arts, *e.g.*, a painting donated to a museum or art gallery, is problematic. Fourth, the Facilitator cannot necessarily restrict benefits to domestic communities, *e.g.* reconstruction of the Versailles palace was funded in large part through tax-exempt contributions made by American taxpayers to the Versailles Foundation in New York City (*Le Figaro* 1980). Fifth, it is difficult to calculate the cost of tax credits and expenditures to government (Wilson 1985, 17). They have been likened to a car with holes in its gas tank. You know how much goes in but not how much is dripping away out of sight.

13.4.3 Patron

1. The Patron State funds the production and conservation of knowledge through arm's length councils in all knowledge domains and some practices, *e.g.*, the Canadian Institutes for Health Research (CIHR). The government determines how much total support to provide, but not which organizations or creators will receive that support. A council is usually composed of a board of trustees appointed by the government. Having been appointed, however, trustees fulfill

their grant-giving duties independent of the day-to-day interests of the party in power, much like the trustee of a blind trust. Granting decisions are generally made through a system of peer evaluation.

2. The grant-giving council supports creativity, discovery and invention with the objective of promoting standards of excellence. The policy dynamic of the Patron State is evolutionary, responding to changing trends and paradigm shifts expressed by knowledge-based communities themselves through peer evaluation.

3. The very strength of the arm's length council is often perceived, however, as its principal weakness. Fostering excellence is sometimes seen as promoting elitism. It may also result in knowledge that is simply not accessible to the general public, or their democratically elected representatives. In most Patron States there are recurring controversies in which politicians, reflecting popular opinion, express anger and outrage at support for various knowledge-based activities perceived, at the time, to be unacceptable, such as child pornography in the guise of Art or fetal tissue research. With an arm's length council, however, politicians can claim neither credit for success nor responsibility for failure. Great Britain is the prime example of the Patron State.

13.4.4 Architect

1. The Architect State funds knowledge production and conservation through ministries, departments and specialized agencies. Bureaucrats, in effect, make grants and spending decisions. The Architect supports knowledge as part of its general social welfare objectives based on the historic tradition of western European culture since the fall of Rome. It was first practiced by the Church in praise of God then of Monarch & Nobility and today, of the citizen and culture of a Nation-State. Since the arrival of democratic government, the Architect role in the Arts, for example, has evolved from ministries of church affairs and culture to ministries of education and culture to a separate and distinct ministry of culture, and sometimes back again.

2. The Architect tends to support established standards and practices rather than creativity, discovery or invention. The policy dynamic of the Architect is revolutionary. Inertia usually results after the entrenchment of established standards developed at a particular point in time. This, in turn, often leads to stagnation as has been observed with respect to the Arts in France (*The Economist*, August 3, 1985, 77-84). This, in turn, may lead to a revolution with the old guard thrown out and a new guard entrenching itself to repeat the revolutionary cycle. The

‘Tomato Revolution’ in Dutch theatre in the 1970s and its subsequent evolution demonstrates the dynamic (Chartrand & McCaughy 1986).

3. The strength of the Architect role is that government can target support according to its priorities. The weakness is that long-term funding can lead to creative stagnation. The most recent example of the Architect is design and development of national innovation systems. In these systems nonprofit academic institutions partner with government and private for-profit actors to create networks of specialized research centres in priority domains, disciplines, sub-disciplines and specialties (OECD 1997). Such centres are intended to facilitate commercial exploitation of new knowledge and enhance the competitiveness of the nation. At the regional and local level this policy fosters clusters of knowledge-based activities to benefit from increasing returns to scale first identified by Marshall as industrial districts in the late 19th and early 20th centuries (Marshall 1920, 271). The contemporary incarnation – industrial clusters – is part of the ‘New Economic Geography’ (Martin & Sunley 1996, 282).

13.4.5 Engineer

1. The Engineer State owns selected, critical and commanding means of knowledge production, distribution and conservation. Five examples will demonstrate. First, each Nation-State, irrespective of ideology, owns and regulates (subject to international treaty) the electromagnetic spectrum and related media of communications including broadcast licensing within its borders. Each consciously plans and decides how this resource will be allocated to further its national purpose. Second, Article XX sub (a) and (f) of the General Agreement on Tariffs and Trade (GATT), now part of the WTO single undertaking, recognizes that a country can control the flow of cultural materials in and out of its borders. In Islamic countries, this ‘morals clause’ is used to stop Western media and its alien portrayal of women. In France – and most of Western Europe – cultural filtering included quotas on movie screens before WWII and after the war, of both film & television to assure ‘national content’ is available.

2. Third, each Nation-State controls the privatization of knowledge and the status of the public domain through IPR legislation. Without such government action a market for new knowledge would not exist. As previously noted, the law is a cultural artifact, *i.e.*, it varies in principle and practice between countries and cultures. IPRs therefore vary significantly between countries. Furthermore, unlike other internationally traded goods and services subject to harmonization under the World Trade Organization (WTO), IPRs are subject to the milder constraint of ‘national treatment’. This means a Nation-State must extend to foreigners the same rights it grants its own citizens but such rights need not be, and generally are not, the same –

nation to nation. This degree of freedom allows government to use IPR legislation as a 21st century equivalent of railroads and transportation infrastructure that made the Industrial Revolution possible (Paquet 1990). Canada's decision to exclude intellectual property from the *North American Free Trade Agreement* suggests that the government of the day either recognized the role of IPRs as critical policy instruments in a knowledge-based economy, or they simply were reserving judgement.

3. Fourth, each Nation-State (at least among First World countries) owns and operates its own knowledge producing facilities. These include central statistical agencies, cultural facilities like that national arts centre, national broadcasting systems, research laboratories, *etc.* While such publicly funded knowledge logically falls into the public domain, many governments have instituted cost-recovery policies that price such knowledge out of the reach of many creators and researchers. In Canada, this policy has led many to rely upon American data sets for which the U.S. government does not charge or charges a modest access fees ([Chartrand Spring/Summer 1997](#)).

4. Fifth and finally, national security considerations are also applied by government to restrict access to certain types of knowledge in both the private and public sector. As the connexion between academic, for profit and public institutions matures under the umbrella of a national innovation system, it can be expected that such restrictions will increase, reducing the flow of free new knowledge. This is, alas, understandable given the growing problem of state-sponsored as well as private sector economic and military espionage. Examples include:

- the long history of state-sponsored economic espionage by France (Whitney & Gainsford 1996);
- strategic considerations in development of 'National Information Infrastructure' ([O'Connell & Tomes 2004](#)); and,
- international controversy over the Echelon satellite surveillance system (operated by the United States, United Kingdom, Canada, Australia and New Zealand - effectively the Anglosphere) that collects virtually all electronic communications on the face of the planet that can then potentially can be used for economic, political and/or military espionage purposes ([Dailey February 24, 2000](#)).

5. Having defined the Nation-State and demonstrated its relationship to the natural Person and the knowledge-based economy, I will now unleash the definitional avalanche about knowledge on the Nation-State to assess the competitiveness of nations in a global knowledge-based economy.

14.0 COMPETITIVENESS

1. I have now progressively and in increasing depth and detail defined knowledge as:
 - a monophonic abstract Platonic noun reflecting the elemental biological human need to know, the immeasurability and incommensurability of knowledge and its general expression in inherently limited human languages including mathematics. The biological need to know constitutes the material cause of knowledge;
 - a diaphonic verb – Science by Design – reflecting that the reductive method including in the experimental sciences *always* take place within the constructive framework of Design. Science by Design constitutes the efficient cause of knowledge;
 - triaphonic forms of personal & tacit, codified and tooled knowledge then expressed as inputs to the production process as codified & tooled capital, personal & tacit labour and toolable natural resources, and as final outputs of that process as the Person, Code and Tool. These three constitute the formal cause of knowledge –somatic and extra-somatic; and,
 - quadraphonic content individuated, socialized, legalized and economized using the etymological WIT, psychological PSI, epistemological EPI, pedagogic PED, legal IPR and economic FLX. Content constitutes the final cause of knowledge – the what, why, who, where and when of knowledge
2. New knowledge contributes to creative destruction (Schumpeter [1942](#), 81-86) of the Nation-State or what Kauffman calls ‘coconstruction’ and ‘coevolution’ (Kauffman 2000, 216). Both the irresistible force (knowledge) and the immovable object (the Nation-State) are organic not mechanical entities. Ideologically, they are ‘epistemic objects’ (Rheinberger [1997](#)).
3. New knowledge affects some or all of the constituent institutions and networks that make up a Nation-State. It mutates their structure, form and function. It alters their ‘fitness’. In the Standard Model of economics, the relevant structure is the production function. The national production function is simply the horizontal summation of the individual production functions of all firms. There is no government. All production is done by private firms while the State buys from such firms using compulsory payments from the population, *i.e.*, taxes. The State is, in this sense, a consumer, not a producer.

4. First, I will examine the term ‘competitiveness’ as used in current debate about the global knowledge-based economy. Second, I will review the production function of a traditional manufacturing-based economy and then re-design it to reflect a knowledge-based economy. Third, I will propose biological ‘fitness’ as a more appropriate and robust criterion than competitiveness. Fourth, and finally, I will consider comparative advantage with respect to knowledge as a noun, verb, form and content. And, as will be demonstrated, comparative advantage is in fact ideologically commensurable between biology and economics.

14.1 Origins

1. As noted by Stéphane Garelli, Director of the World Competitiveness Project, some scholars believe that the Nation-State does not compete, only business enterprise (Garelli 2002). This flies in the face of history. The Nation-State is the most complex organizational form yet evolved. It functions in an environment populated by other Nation-States. In one form or another, it has been involved in competition with its fellows since before recorded history, often the most violent competition - war. Even in times of peace, Nation-States constantly defend and strive to extend their influence and power through diplomatic and other means including state-sponsored industrial espionage (Whitney and Gaisford 1996). And war, of course, is but “the continuation of state policy with other means” (Clauswitz 1832).

2. With the fall of the Berlin Wall the search began for the pattern or *leitmotif* of the new post-Cold War world. For Samuel Huntington, it was “The Clash of Civilizations?” (Huntington 1993); for Robert Kaplan, it was “The Coming Anarchy” (Kaplan 1994). A very different set of scenarios were cast, however, at about the same time. One concerned alternative futures for the “information superhighway”, the graphic or icon-based World-Wide Web (WWW) which appeared in 1994. Another set concerned corporate and national competitiveness in a global economy.

3. With respect to the WWW, on the one hand, this electronic gateway appeared to open onto Marshal McLuhan’s pastoral “global village” with free access to knowledge by all anywhere in the world. The distant poor of the Third and Fourth Worlds would ‘plug in’ and prosper with their new found knowledge. On the other hand, the Net” was portrayed as a cybergothic nightmare as charted by William Gibson in a series of novels written between 1984 and 1993 (Gibson 1984, 1986, 1988, 1993). In Gibson’s version of the webbed future, the mind’s eye fills with swirling multimedia, merging and mutating into a consensual hallucination called “cyberspace” (a term coined by Gibson). This virtual reality rushes forward fueled by techno-greed for knowledge contained in streaming columns of bits and bytes graphically

portrayed in the Wachowski Brothers' motion picture *The Matrix* (Wachowski Bros. 1999). Hackers, or what in 1984 Gibson called "console cowboys", fight for encrypted information using identity theft, spam, Trojan Horses, viruses and worms as well as 'black ICE', *i.e.*, intrusions countermeasures electronic, often fatal to hackers. In the process, individuality and privacy erode before the ceaseless search for knowledge by corporate techno-elites that know which buttons to push while the rest of humanity cannot program a VCR. In Gibson's future, corporations (and governments) protect know-how and trade secrets by implanting "neural bombs" in employees. If an employee's loyalty slips, the bomb goes off killing or mentally maiming: the bottom line, knowledge is protected. Even artificial intelligence has a place in Gibson's world qualifying for citizenship in Switzerland (Gibson 1984).

4. A very different information-based scenario emerged, however, with the 1992 *World Competitiveness Report* published by the World Economic Forum and the Institute for Management Development in Geneva, Switzerland since 1980 (WEF & IMD 1992, 3). This report introduced the concept of "the softer side of competition" reflecting the shift to a knowledge-based economy. It noted that in "the industrialized world today, only 15% of the active population touches a product. The other 85% are adding value through the creation, the management and the transfer of information" (WEF & IMD 1992, 4). This scenario I call the competitiveness of nations in a global knowledge-based economy.

5. Economic competitiveness has always been with us. Contemporary usage, however, extends traditional mass market price competition to "working smarter" in response to consumer demand for higher quality more customized goods and services, globalization and technological advance. Competitiveness promises profitable and progressive industries, more satisfying jobs, higher salaries and higher tax revenues collected at lower rates to supply social investment in deficit and debt retirement, education, health, infrastructure and welfare. It promises to make one's country, community or company "top dog" in a confusing kaleidoscopic post-Market/Marx world in which former enemies are now trading partners.

6. Competitiveness is generally expressed in sports metaphors such as: "skating where the puck is going, not where it is" which captures its anticipative nature (Wilson 1992). In this game, however, some win and some lose in an "us/them" conflict deciding the destiny of our children, our communities and our country. Arguably, global competitiveness has ideologically quenched the last embers of the '60s revolution of rising expectations. Fear of job loss has smothered the hopes of citizen consumers and workers. Instead of George H. Bush Sr.'s "kinder and gentler society", we live with George W. Bush Jr.'s fear of downsizing, obsolescence, outsourcing, privatization, redundancies and technological displacement. This threatens:

- living to work rather than working to live;
- vocational training and specialization rather than education and cultural rounding;
- fear of job loss rather than pride in one's work; and,
- fear of the Third World and immigrants as threats to economic security, not partners in a cosmopolitan, cultivated, equitable, peaceful, prosperous, stable and tolerant tomorrow.

7. A global knowledge-based economy, however, is not just a Darwinian struggle for individual, corporate, communal or national survival. Arguably it is the apotheosis of the human species marking its “departure or release from earthly life” (OED, *apotheosis*, 4). Born of the earth, humanity driven by its biological need to know has spawned a global economy based on intangible virtual property called knowledge. And with this knowledge it has got itself into outer space, certainly a departure from earthly life.

8. Whether the global knowledge-based economy becomes a heaven or a hell on earth, the game is afoot. National innovation systems are being constructed. Educational systems are being transformed including re-introduction of standardized testing. Intellectual property rights are continually being updated in an effort to keep up with new technological matrices to codify and tool knowledge. Firms are appointing Chief Knowledge Officers. And, in this game, the object at play is the production function of the firm and Nation-State.

14.2 Production Function

1. The concept of the production function is perhaps the most elegant contribution of economics to human thought. It is the recipe of inputs (factors of production) to maximize the output of a firm or nation. It is defined “by a given state of technical knowledge” (Samuelson 1961, 570). In symbolic form, a production function can be expressed as:

$$Y = f^t (K, L, N)$$

where:

Y = output

f = some function of ...

K = capital

L = labour

N = natural resources

t = time

2. This reads: Output (Y) is some function (f) in a given time period (t) of capital (K), labour (L) and natural resources (N). In effect, the state of technical knowledge, or technology,

is implicit in the ' f ' of the equation. It is the recipe. How much of each input, in what combinations and under what conditions can ingredients be mixed to produce maximum output and minimize cost? This is technology. It is also time specific, *i.e.*, it has vintage.

3. If the object at play, the ball or puck, is the production function then each firm or nation is a team constantly adjusting its play to gain advantage over its opponents. For a knowledge-based economy, the production function and each of its parameters can now be stated in terms of knowledge. I will briefly summarize inputs and outputs and then present a re-designed production function for a knowledge-based economy.

14.2.1 Inputs

1. The traditional factors of production – capital, labour and natural resources - can be expressed as codified & tooled capital, personal & tacit labour and toolable natural resources.

2. Capital is codified and tooled knowledge, *i.e.*, knowledge fixed or tooled into an extrasomatic matrix. It is “knowledge imposed on the material world” (Boulding 1966, 5), or, “frozen knowledge” (Boulding 1966, 6). It comes in two forms:

- codified knowledge as human-readable information management systems and databases, operating manuals and libraries as well as associated intellectual property rights such as copyrights, patents, registered industrial designs and trademarks; and,
- tooled knowledge as ‘hard-tooled’ plant and equipment plus related ‘soft-tooled’ knowledge such as machine-readable computer & genomic programs, standards and techniques.

3. Labour as personal & tacit knowledge is somatically fixed in an individual as neuronal bundles of memories and the trained reflexes of nerve and muscle. It comes in three forms: productive, managerial and entrepreneurial.

4. Initially a natural resource may appear simply part of the environment – animal, plant, mineral, *etc.* With new knowledge, however, such environmental artifacts become recognized as toolable into goods and services serving human purpose, satisfying human wants, needs and desires, *i.e.*, all of Nature will eventually become toolable natural resources as humanity technologically enframes its environment, *i.e.*, planet Earth.

5. At any given point in time there is a given stock or quantity of factors of production. In the Standard Model, physical capital stock is static or fixed in the short-run until additional factors are acquired in the long run. In a knowledge-based economy, however, codified and tooled capital is not static but rather dynamic and organic, exhibiting mutation, change and

increase even with no new additions. Fusion and fission takes place. For example, with no additional capital plant and equipment, labour can learn (personal & tacit knowledge) how to use existing equipment more effectively and tinker with it (development) to maintain or improve its capacity.

6. In this way, inputs to a knowledge-based economy are more like financial rather than physical capital. The English word ‘stock’, in its financial sense, is not found in any other language except by adoption. Its origin is obscure linking a trader's capital to a trunk or stem from which gains are the outgrowth (OED, *stock*, VI).

14.2.2 Outputs

1. The economic value of knowledge is satisfaction of the human biological need to know:
 - a) *directly* through final goods or services satisfying carnal as well as intellectual, emotional and intuitive needs to know; and,
 - b) *indirectly* through intermediate or producer goods and services used to create final ones and which, in the production process, become part of the final product or lose their identity.
2. Knowledge takes three forms as an intermediate output (a means to an end) and as a final consumer good (valued in-and-of-itself) - the Person, Code and Tool. For clarity, I restrict Person to the natural person possessing personal & tacit knowledge. I restrict Code to matter coded to carry semiotic meaning from one human mind to another. I restrict Tool to matter tooled to carry function, *i.e.*, to measure and/or manipulate the physical world as sensor, tool or toy. A Code or Tool, however, have meaning or function only through the agency of a Person. In this sense, the Person is the ultimate input and output of a knowledge-based economy. And in the guise of personal & tacit labour one can meaningfully speak of a ‘labour theory of knowledge’.
3. Knowledge outputs serve three primary purposes. First, a knowledge output may serve *knowledge-for-knowledge-sake*. In the philosophy of science this is associated with the research community embracing universities, colleges and affiliated research institutes. The importance of academic research is that it is not restricted by immediate applicability. In aesthetics, *i.e.*, the fine arts, it is associated with *art-for-art’s-sake*. Consumer demand to know for the sake of knowing also should not be under-estimated as demonstrated by the success of the entertainment industry, NASA and other scientific as well as religious institutions. The hunger to know is a force that moves budgets.

4. Nonetheless, *traditionally* Art and Science are subject to epistemic limits. In the natural & engineering sciences, knowledge by sight is dominant, *i.e.*, seeing the numbers, seeing the graph, seeing is believing (Idhe 1991). Other senses are suppressed. In aesthetics, the distant senses of sight and sound are dominant with the contact senses of taste, touch and smell suppressed (Berleant 1964). In economics, however, knowledge-for-knowledge-sake is subject to no epistemic inhibition. Limitations of law may *artificially* restrict our means but do not stop us from pursuing our pleasures. The failed attempts to prohibit ‘forbidden knowledge’ such as prostitution (carnal knowledge) and drugs (altered states of conscious) are examples. If there is a human need to know, the first economic question becomes: Is there a profit to be made? The second: Is there a law limiting that profit? The third: Is there a way around the legal limitations? In this sense, economics is an amoral rather than an objective science.

5. Second, any output (Person, Code or Tool) may serve a utilitarian purpose such as *knowledge-for-decision-or-profit*. In the societal guidance mechanism (public, profit and nonprofit), knowledge supports policy development and program implementation as well as product development, innovation, production and marketing. In the military, knowledge as ‘intelligence’ plays a similar role. The reality of decision (public, profit, nonprofit or military), however, is that it is inevitably subject to time and therefore knowledge constraints. As revealed by Eric Jantsch (1967) in his pioneering survey of technological forecasting and assessment for the OECD, there is never enough time or enough knowledge to make a fully rational decision. ‘No-knowledge’, *i.e.*, knowing without knowing how one knows, inevitably plays a role. The most a decision maker can achieve is ‘informed intuition’. This is consonant with the failure of calculatory rationalism in the Communist Bloc during the Market/Marx wars. Von Hayek was right. Simply put, there is more to knowledge than calculation. Local knowledge combined with an anonymous price system works best. Abstract knowledge combined with human hubris works worst.

6. Third, a knowledge output (Person, Code, Tool) may serve as *knowledge-for-ethos* reinforcing or disestablishing, *e.g.*, revolutionary tracts, the characteristic spirit, beliefs and customs of a nation, community, firm or individual. The most extreme examples are mass conversions initiated by an Abraham, Moses, Christ, Mohammed, Buddha and Confucius as well as more recent examples of the Republican and Communist Revolutions. The citizen is motivated by the need to know about his or her world. How wide or narrow this need will be varies between individuals and the times in which they live. Ethos is the world of Walter Lippman’s *Public Opinion* and “the pictures in our heads”, *i.e.*, that part of the world that we

cannot experience directly through our native senses (Lippman 1922). This is the public domain of a knowledge-based democracy fed by a free press.

14.2.3 Reconciliation

1. The production function of a knowledge-based economy (KBE) is displayed as Exhibit
2. It reads: Output ($Y = \text{Persons, Codes and Tools}$) is some space/time period (s, p) function (f) acting on an embodied stock (e) of codified & tooled capital (K), personal & tacit labour (L) and toolable natural resources (N) subject to continuous endogenous (n), disembodied (d) and exogenous (x) technological change and to changing government policy (g) fostering or inhibiting specific knowledge domains and practices (EPI), disciplines and specialities (PED) and intellectual property rights (IPR).
2. In contrast to the production function of a traditional manufacturing-based economy, the KBE production function:
 - transforms all factors of production (K, L, N) and outputs (Y) into knowledge that is ultimately personal & tacit;
 - defines each factor and output by a unique set of knowledge qubits, *i.e.*, $\sum q = (\text{WIT, PSI, EPI, PED, IPR, FLX})$;
 - introduces location (s) as well as the historical time period (p) as a salient variable;
 - introduces organizational (HSS) and design (Arts) technology to compliment physical (NES) technological change;
 - introduces Government (g) as a defining variable by selectively fostering or inhibiting specific knowledge domains and practices (EPI), disciplines and specialities (PED) and intellectual property rights (IPR);
 - integrates disembodied (d), embodied (e), endogenous (n) and exogenous (x) technological change into the same production function;
 - expresses personal & tacit and codified & tooled knowledge as the staple commodities of a global knowledge-based economy; and,
 - resolves the schism between capital and labour subsuming human capital as well as managerial and entrepreneurial talent under personal & tacit labour.
3. If the production function is the object at play in the global-knowledge-based economy then each firm and nation is a team constantly adjusting and refining strategy, tactics and logistics to gain competitive advantage over opponents. The question, however, arises: Is sports-based competitiveness the appropriate criterion of success?

Exhibit 2 Production Function of a Knowledge-Based Economy

$$Y = f^{s,p}(K^e, L^e, N^e)^{d,n,x,g} \quad (1)$$

where:

Y = Person, Code & Tool
K = codified & tooled capital
L = personal & tacit labour
N = toolable natural resources
f = some function of
s = space
p = time period or era
d = disembodied technological change *
e = embodied technological change *
n = endogenous technological change *
x = exogenous technological change *
g = government **

and,

$$e = h(P, O, D) \quad (2)$$

$$d = g(P, O, D) \quad (3)$$

$$n = i(P, O, D) \quad (4)$$

$$x = j(P, O, D) \quad (5)$$

where,

$g, h, i \& j$ = some function of

and,

P = physical technology ***

O = organizational technology ***

D = design technology ***

where,

$$P = \alpha(p, c, t) \quad (6)$$

$$O = \beta(p, c, t) \quad (7)$$

$$D = \gamma(p, c, t) \quad (8)$$

and,

α, β, γ = some function of

where,

$$p = \text{personal \& tacit knowledge} \quad (9)$$

$$c = \text{codified knowledge} \quad (10)$$

$$t = \text{tooled knowledge} \quad (11)$$

and,

$$p, c \& t = \sum Q (\text{WIT, PSI, EPI, PED, IPR, FLX})^{****} \quad (12)$$

where,

Q = a combinatory set of knowledge Qubits

Notes

* Technological Change: impact of new knowledge on the production function of a firm or nation,; disembodied (systemic) or embodied (localized); and endogenous or exogenous to the firm or nation

** Government: as 'rule maker' of intellectual property rights and national innovation systems. While government partners with private owners decision making is political and exogenous to the economic system. It acts as Custodian, Facilitator, Patron, Architect and/or Engineer of the national knowledge-base.

*** Physical Technology from the Natural & Engineering Sciences (NES); Organizational from the Humanities & Social Sciences (HSS); Design from the Arts - literary, media, performing & visual.

**** A Qubit is a four-fold unit of knowledge including the etymological WIT (knowing by the senses, mind, doing, experience); psychological PSI (knowing by Reason, Revelation, Sentiment, Sensation); epistemological EPI (knowing by the NES, HSS, Arts, Practices); pedagogic PED (knowing by domain/practice, discipline, sub-discipline, speciality); legal IPR (knowledge fixed in a utilitarian or non-utilitarian matrix, Person or public domain); and, economic FLX (knowledge as disembodied, embodied, endogenous or exogenous technological change)

14.3 Fitness

1. In sports, it is the opposing team that is the challenge. The playing field, the environment itself, is generally fixed, invariant and subsidiary to the consciousness of players at play. In biology, however, natural selection involves not just an opponent but also new invariants and affordances thrown up by an ever changing environment. In this sense Darwinian fitness is not simply bodily strength, intelligence, vigor or bravery *vis-à-vis* rivals. Rather, fitness is a compounded result of the mutual relationship between an organism and its environment including symbiotic as well as predator/prey relationships. And, as will be seen, symbionts can significantly enhance fitness, *i.e.*, the probability one will survive and leave descendants.

2. A fitness landscape is thus constantly changing, altered and distorted by perpetual adaptation by competitors and symbionts as well as environmental variation and change such as increased heat or cold, wet or dry and the rise and fall of mountains, *etc.* Shifting to a biological metaphor expands focal attention to include the environment and symbionts, dimensions the sports analogy does not readily capture.

3. In this regard, Kauffman has extended fitness in molecular biology to the economy, or the 'econsphere' (Kauffman 2000, 211-241). He argues humanity exhibits the same basic pattern of behaviour as all life - making a living:

The parallels are at least tantalizing, and probably more than that. While the mechanisms of heritable variation differ and the selection criteria differ, organisms in the biosphere and firms and individuals in the econosphere are busy trying to make a living and explore new ways of making a living. (Kauffman 2000, 216)

4. I will now examine three of Kauffman's principle ideas: the autonomous agent, coevolution/coconstruction and the adjacent possible. I will then apply them to a concept he finds commensurate with economics: comparative advantage. Arguably, what Malthus did for biology by inspiring Darwin, David Ricardo did for Kauffman.

5. Kauffman's intellectual affinity with economics as well as his debt and contribution to it is apparent throughout his work. In this regard, he recommends a series of very sophisticated mathematical techniques for application in economics. Their sophistication is such that I am not qualified to judge their internal workings or technical merits. I have, however, strong epistemic reservations, as previously noted, about low grade social scientific data fueling ever more sophisticated mathematical models, *i.e.*, garbage in garbage out. Such low quality evidence

should not be confused with that generated, relatively speaking without human mediation, by the instrumental experimental natural & engineering sciences including biology.

14.3.1 Autonomous Agents

1. Kauffman's central concept is the autonomous agent (Kauffman 2000, 49-79). This is a Kantian-like entity with natural purpose acting on its own behalf in an environment and able to reproduce itself through "thermodynamic work cycles" (Kauffman 2000, 49). For Kauffman, such work cycles involve, in almost Heideggerian fashion, the constrained or enframed linkage of endergonic (energy requiring) and exergonic (energy releasing) chemical reactions whereby:

the coherent organization of ... constraints on the release of energy ... constitutes the work by which agents build further constraints on the release of energy that in due course literally build a second copy of the agent itself..." (Kauffman 2000, 72)

2. Kauffman thus extends Kant from the cellular to the molecular level where he finds autocatalytic sets of "self-reproducing molecular systems" (Kauffman 2000, 130). In effect, he finds the origin of life in chemistry. He argues that life is the inevitable outcome of some threshold concentration of organic chemicals widely dispersed throughout astronomical space. While this may be so, like Kant asserting there would never be a Newton for a blade of grass, Kauffman concludes that while linking exergonic and endergonic reactions is essential to definition of an autonomous agent, life itself is a "mysterious concatenation of matter, energy, information, and something more ..." (Kauffman 2000, 47).

3. In the biosphere there is also a hierarchy of autonomous agents. Kauffman points to the evolutionary transition from single-cell organisms without nuclei, prokaryotes, to eukaryotes, *i.e.*, single-cell organisms with a nucleus *plus* mitochondria in animals or plastids in plants using chlorophyll. He concludes that:

eukaryotic cells are symbionts of two or more earlier separate autonomous agents that contributed the mitochondria, the plastids, and perhaps the nuclear structure of eukaryotes into a single novel reproducing entity, the eukaryotic cell. (Kauffman 2000, 120)

4. Life, of course, has burgeoned far beyond single-celled creatures. Kauffman notes there are some 265 different cell types in the human body (Kauffman 2000, 182). Each is an autonomous agent. Each, however, collectively combines to form a higher order agent – an organ – that, in turn, forms a functioning part of a yet higher order agent – the individual human being. Kauffman takes this hierarchy up from the geosphere of chemistry to the biosphere to the noosphere and beyond to the universe itself. The process I characterize as the increasing diversity and complexity of autocatalytic systems pursuing Kantian natural purpose.

14.3.2 Coevolution & Coconstruction

1. The mechanism driving increasing diversity and complexity is coevolution defined as the mutual evolutionary influence of two species (molecular, organic or social) that become dependent on each other. Each exerts selective pressures on the other, thereby affecting each others' evolution. This often involves morphological coconstruction, *e.g.*, the shape of an orchid flower matching the bill of the hummingbird. Coevolution and coconstruction apply in both symbiotic and predator/prey relationships between autonomous agents.

2. In fact, Kauffman argues that the primary mechanism of molecular evolution is not the template model of sequentially constructing DNA step-by-step up the ladder. Rather it is through coconstruction of its segments by sets of mutually dependent autocatalytic molecules that then integrate the parts into a new coherent living whole. This catches the Kantian sense that "each part is reciprocally means and end to every other. This involves a mutual dependence and simultaneity that is difficult to reconcile with ordinary causality" (Greene & Depew 2004, 94).

3. Given an ever changing fitness landscape, autonomous agents constantly adapt, adjust and evolve or go extinct, *e.g.*, out of business, sometimes in avalanches of change. They do so by experimenting with mutations called preadaptations or exaptations which:

... in an appropriate environment [are] a causal consequence of a part of an organism that had not been of selective significance [but] might come to be of selective significance and hence be selected. Thereupon, that newly important causal consequence would be a new function available to the organism." (Kauffman 2000, 130)

Arguably, in a knowledge-based economy, research & development (R&D) plays a commensurable role. It should be noted, however, that the concept of the self-organizing universe based on coevolution was first (to my knowledge) put forward by Eric Jantsch in *Design for Evolution* (1975) and then *The Self-Organizing Universe* (1980).

4. There are at least two other important characteristics of life on a fitness landscape. First, having reached a peak of fitness if the rate of mutation, change or experimentation becomes too rapid, *i.e.*, crosses some threshold, then "the population 'melts' off the fitness peak and wanders away across the fitness landscape" (Kauffman 2000, 155). As will be argued below, this may be the case with some traditional First World countries. Second, among the many border or transition states identified by Kauffman as characteristic of life one of the most intriguing is that life exists on the quantum/classic frontier.

... it is probably of more than passing interest that real living entities, cells, do straddle the classical and quantum boundary. One photon hitting a visual

pigment molecule can beget a neural response. In short, real living systems straddle the quantum classical boundary. If there is a tendency of coevolving autonomous agents to increase the diversity of alternative events that can occur, then living entities must eventually hit the Heisenberg uncertainty limit and abide at least partially in the quantum realm. (Kauffman 2000, 149)

14.3.3 Adjacent Possible

1. But from where do preadaptations and exaptations come? According to Kauffman, using chemical reaction charts as his model, they come from the ‘adjacent possible’ consisting “of all those molecular species that are not members of the actual, but are one reaction step away from the actual” (Kauffman 2000, 142). Extended to the noösphere, it is those thoughts and ideas which are candidates for application at the next level of ideological evolution. Economic and biological systems expand or explore the adjacent possible as quickly as possible subject to timely selection of the fit and unfit, *e.g.*, going out of business. If selection takes too long, then fitness may decline or simply melt away. Arguably, this explains ‘de-industrialization’ of some First World Nation-States. They maintained existing plant and equipment, *e.g.*, in steel production, until fully depreciated through voluntary (and sometimes involuntary) quotas on imports from developing Asian producers who were investing in the best new technologies emerging from the adjacent possible. The fitness of the West fell, at least in terms of the traditional manufacturing-based economy.

2. A characteristic of the chemical adjacent possible is that its size (its possibilities) increases exponentially faster than the increase in the diversity, complexity and number of autonomous agents. For example, a doubling in diversity may result in a fourfold or greater increase in the size of the adjacent possible, *i.e.*, the number of new possible forms just one step away from becoming actual. This, Kauffman argues, is one reason for the proliferation and diversification of life. The same may be said for knowledge itself. From this conclusion he argues that there is: “a tendency for self-constructing biospheres [and econospheres] to enlarge their workspace, the dimensionality of their adjacent possible, perhaps as fast, on average, as is possible ...” (Kauffman 2000, 244). This means an exponential increase in the ways and means by which autonomous agents make a living is the inevitable outcome of increased diversity and complexity. The transition from an agricultural- to a manufacturing-based economy demonstrates such an exponential increase in job opportunities, not just in number but in the kinds of jobs.

3. Kauffman is, however, critical of contemporary economics for its treatment of compliments and substitutes in what he calls the technological adjacent possible. Quite simply,

the Standard Model offers no explanation for the emergence of compliments or substitutes or for the increasing diversity and complexity of new goods and services, *e.g.*, the book versus the DVD player. Kauffman uses the classic example of the automobile replacing not just the horse but also the network of goods and services associated with it. He points out the new web of compliments that followed innovation or emergence of the automobile. These included paved roads, garages, gasoline stations, parking lots, car insurance, the drive-in, then the drive-thru, *etc.* Such ‘Kauffman webs’ are, at least in part, commensurate with Paul David’s “network externalities effects” in economics (David 1990, 356). Kauffman would have us, however, look much deeper into the adjacent possible for compliments and substitutes to enhance economic fitness.

14.4 Comparative Advantage

1. If the production function is the most elegant contribution to thought by economics, *i.e.*, $Y = f(K, L, N)$, then the theory of comparative advantage is one of its most obscure. When challenged by mathematician Stanislaw Ulam to “name me one proposition in all of the social sciences which is both true and non-trivial,” the Nobel Prize winning economist Paul Samuelson responded with the theory of comparative advantage because:

That it is logically true need not be argued before a mathematician; that it is not trivial is attested by the thousands of important and intelligent men who have never been able to grasp the doctrine for themselves or to believe it after it was explained to them. (Samuelson 1969)

2. This obscurity partially results because the theory engages a complex web of economic ideas including absolute advantage, division and specialization of labour, exchange, factor endowments, opportunity cost, production possibility frontiers, relative prices and trade. Furthermore, it would more accurately be called the theory of comparative cost rather than of advantage. And, of course, some of its results appear counter-intuitive.

3. Semantic obscurity has lead to the theory finding general expression as a numeric example such as that first used by David Ricardo to demonstrate the theory in his 1817 book *The Principles of Political Economy and Taxation*. In his case, it concerned wheat and wine production in England and Portugal. In summary, comparative advantage means that mutually beneficial exchange is possible whenever relative production costs differ prior to trade. One of its counter-intuitive deductions, however, is that if a country enjoys an absolute advantage in the production of all goods and services, *i.e.*, can produce all of them cheaper than anyone else, it is still better off trading with other countries. The theory was used by Ricardo to counter

arguments in favour of protective tariffs and trade barriers which, intuitively, promise national prosperity. It continues to serve this free-trade purpose.

4. The theory of comparative advantage, in effect, separates consumption from production. Without trade, a nation can only consume what it produces. With trade, it is able to consume *more* than it produces. Put another way, by specializing in what it does best, a nation can afford to buy more of what it does worst.

5. For Kauffman, and biology in general, the advantages of trade are old news:

Economics has its roots in agency and the emergence of advantages of trade among autonomous agents. The advantages of trade predate the human economy by essentially the entire history of life on this planet. Advantages of trade are found in the metabolic exchange of legume root nodule and fungi, sugar for fixed nitrogen carried in amino acids. Advantages of trade were found among the mixed microbial and algal communities along the littoral of the earth's oceans four billion years ago. The trading of the econosphere is an outgrowth of the trading of the biosphere. (Kauffman 2000, 211)

6. To demonstrate the advantages of trade, Kauffman uses a biological example that, to my mind at least, is intuitive:

Consider two bacterial species, red and blue. Suppose the red species secretes a red metabolite, at metabolic cost to itself, that aids the replication rate of the blue species. Conversely, suppose the blue species secretes a different blue metabolite, at metabolic cost to itself, that increases the replication rate of the red species. Then the conditions for a mutualism are possible. Roughly stated, if blue helps red more than it costs itself, and vice versa, a mixed community of blue and red bacteria may grow. How will it happen? And is there an optimal "exchange rate" of blue-secreted metabolite to red-secreted metabolite, where that exchange rate is the analogue of price? (Kauffman 2000, 216-17)

7. How it will happen and at what rate it will happen is determined by coevolution. The benefits of trade lead each to adjust to the other until optimal growth is achieved by both. Without each others help, individually, each would be less fit. In such a symbiotic relationship there is also potentiality for emergence of a higher order autonomous agent, *e.g.*, prokaryotes coevolving into eukaryotes.

8. For the Nation-State, as an autonomous agent, at any given point in time there is a knowledge endowment with which to specialize and trade. It consists of a unique mix of knowledge as noun, verb, form and content (Exhibit 3). It is composed of codified & tooled

Exhibit 3
National Knowledge Endowment

KNOWLEDGE AS NOUN

<i>Biological Need</i>
<i>Immeasurability</i>
<i>Incommensurability</i>
<i>Language</i>

AS VERB

Methodology <i>Trans-Disciplinary Induction</i>	
Science (Reduction)	Design (Construction)

AS FORM

Form/Input/Output			
Form	Personal & Tacit	Codified	Tooled
Input	Personal & Tacit Labour	Codified & Tooled Capital	Toolable Natural Resources
Output	Person	Code	Work

AS CONTENT

Event Horizon	<i>QUBIT</i> *				
Etymology **	<i>WIT</i>	Senses	Mind	Doing	Experience
Psychology ***	<i>PSI</i>	Reason	Revelation	Sentiment	Sensation
Epistemology ****	<i>IMP</i>	NES	HSS	The Arts	The Practices
Pedagogy	<i>PED</i>	Domain/Practice	Discipline	Sub-Discipline	Specialty
Law *****	<i>IPR</i>	Utilitarian	Non-Utilitarian	Person	Public Domain
Economics *****	<i>FLX</i>	Disembodied	Embodied	Endogenous	Exogenous

* A four-fold measure of knowledge

** Derived primarily from the Oxford English Dictionary (OED)

*** From Analytic Psychology terms for the four human faculties of knowing: thinking, intuition, feeling and sensation

**** NES = Natural & Engineering Sciences

HSS = Humanities & Social Sciences

Arts = Literary, Media, Performing & Visual Art

Practices = Accounting, Architecture, Engineering, Law, Medicine & other self-regulating professions

***** Legal requirement that new knowledge be fixed in a material matrix to qualify for protection.

***** Technological change in Economics is defined as the impact of new knowledge on the production function of the firm or nation..

capital, toolable natural resources as well as routinized patterns of behaviour and values, *i.e.*, institutions, embodied as personal & tacit labour. This endowment is inherited from the past as a social genetic code, adapted in the present then transmitted to future generations if the Nation-State is to survive.

14. Components of a national knowledge endowment emerge at different points in a national historiography. Some emerge at the beginning, *e.g.*, the U.S. military won the revolutionary war, while others appear later, *e.g.*, the National Endowment for the Arts. The law of primacy applies. The first colours all subsequent components. Put another way, a national creation myth informs development of the Nation-State. The endowment is, in effect, composed of strands of overlapping temporal gestalten (Emery & Trist 1972) or epistemes (Foucault 1973) woven together into the present. Holistically, it is the ethos of a nation. Of course, the quality of the weave and its pattern changes and evolves through time. Such a view contradicts the concept of 'modernity' as the homogenous co-temporality of all sectors of society. Instead, the Present is seen as a fabric woven out of uneven and unequal strands stretching ontologically backwards into the Past of a Nation-States' culture, language, religion, *etc.*. In this sense Time's Arrow runs both backwards and forwards in the noösphere.

10. I will now present a sketchy and impressionistic assessment of the competitiveness of nations in a global knowledge-based economy. I assume an initial national endowment of knowledge as noun, verb, form and content. I consider national comparative advantage with respect to each of these components (Exhibit 3). I will also map out some alternative fitness pathways towards the enhanced competitiveness of nations in a global knowledge-based economy.

11. Before doing so, however, three qualifications are in order. First, as previously noted, there is a wide variety and diversity among the 191 Nation-States that are members of the United Nations in 2005. They vary by geographic and population size, by resource endowment, language and culture. There are also an increasing number of regional trading blocs operating under the WTO global umbrella. Entities such as the Andean Community, European Union, Mercosur and NAFTA are, in some cases, arguably higher order autonomous agents relative to their member States. On the other hand, tiny Nation-States such as Monaco and East Timor are arguably of a lower order. I will not, at this time, attempt to distinguish between types of Nation-States or symbiotic supra-national entities.

12. Second, the Nation-State is not the only autonomous agent operating in the global economy. What was called 'multinational' in the 1960s then 'transnational' and finally 'global'

business enterprise has grown in size and complexity surpassing many Nation-States. Similarly, international institutions such as the World Bank, International Monetary Fund, World Intellectual Property Organization (WIPO) and the WTO act sometimes as symbionts fostering, and at other times constraints on, the autonomy of the Nation-State. I will not, at this time, treat the implications of global private enterprise and international institutions.

13. Third, it is important to recognize a bias inherent in Kauffman's system of ideas, his ideology. It supports a Republican concept of the Person as the elemental autonomous agent of human society. Next up on his hierarchy is the for-profit business enterprise or the firm. Increased autonomy, complexity and diversity of the Person plus free enterprise enhance, according to Kauffman, the fitness of a human society. He makes no explicit reference to 'community' or to the Nation-State.

14. Ideologically, this contrasts with the Communist concept of the person as an homogenized component of a Class which, in terms of socialist realism, is the actual autonomous agent. In this regard, Emery & Trist in their 1972 *Towards a Social Ecology* highlighted the distinction between redundancy of control (Communist) and redundancy of function (Republican). The former sought to standardize individual behaviour using overlapping layers of hierarchical control; the later continues to *personalize* behaviour fostering increasing complexity and diversity of human wants, needs and desires. I will not, at this time, examine implications of this distinction. I will, however, provide some indication of the importance of redundancy to the fitness of a Nation-State. I now begin my sketch of the comparative advantage of a national endowment of knowledge as a noun, verb, form and content.

14.4.1 As Noun

1. As a noun, knowledge is monotonic, immeasurable and incommensurable. Nonetheless, a distinction can be made between knowledge and 'not knowledge', *i.e.*, that which is censored, excluded, ignored or otherwise denied status as knowledge. Any assessment of a national knowledge endowment begins with cultural choices, historically made, as to what is and is not acceptable as knowledge. In effect, each Nation-State sees the world through its own coloured glasses. What is acceptable and legitimate knowledge in one may be denied and subject to criminal sanction in another, *e.g.*, images of women in the 'secular' West versus those on Saudi Arabian television.

2. While much of a national endowment results from non-discretionary historical forces, some result from conscious current choice. In fact, government has censored and suppressed

knowledge throughout history. Whether it was Roman emperors burning Christians and their tracts or Christian zealots burning the Library at Alexandria or the first emperor of China burning 2500 years of recorded history or Adolph Hitler's book burnings or those of Mao during the Cultural Revolution, some knowledge is not allowed to be studied or preserved. It is forbidden knowledge. It is a choice that, as will be seen, has an opportunity cost, *i.e.*, the next best alternative foregone.

3. It is not, however, just codified knowledge that is censored and suppressed. Three examples of tooled knowledge demonstrate. First, the ancient Indus Valley culture (about 3,000 to 1,500 B.C.E.) appears to have rejected a new technology of war - the socket-headed axe. It then fell under the blows of invaders who adopted it (Piggott 1950). Second, early in the 15th century China had gunpowder and transoceanic sailing fleets that dwarfed those of Columbus (Diamond 1997) but to maintain harmony in the Middle Kingdom the Emperor burnt the vessels, their plans, shipyards and shipwrights. China was, of course, subsequently partitioned by the heirs of Columbus. Third, medieval Islamic medicine was the best of its time. But the human body, created in God's image, is, in Moslem tradition, a temple not to be violated. When dissection emerged in Western Europe as the next step in medical science, Islamic law inhibited its use and Islamic medicine rapidly fell behind. These societies succeeded in suppressing tooled knowledge but at the price of decline and/or fall.

4. Two contemporary examples demonstrate the opportunity costs associated with rejection. First, the People's Republic of China wants Chinese culture recognized by UNESCO as one of the founding human civilizations along with the ancient Egyptians and Sumerians (Eckholm 2000). There is a written record tracing the ancient Egyptian and Sumerian civilizations, dynasty by dynasty, back to at least 3,000 B.C.E. The Chinese government, however, is frustrated because much of the written record prior to the great book burning of the first emperor, Qin Shi Huangdi, in 213 B.C.E. literally went up in smoke (Wilhelm, 1950, xlvii) together with his alleged aphorism: Before Me, No History!

5. A second example is contemporary genomics. Genomics is not a single technology but rather a multi-purpose tool or engine, like the computer. It has the potential of affecting every sector of the economy and society. Resistance to genomic innovation tends therefore to be sectoral and selective rather than general or across the board. This is evident with respect to fetal tissue research. Sweden has embraced it; Britain regulates it; the United States rejects it; and, Canada hasn't made up its mind. Similarly, xenogenetic transplants to humans, especially from the standard animal surrogate, the pig, will not be accepted in Islamic or Jewish cultures. The fact that the European Union is resistant to genetically modified foodstuffs but accepting of

medical genomics while the reverse appears the case for the United States highlights the potentially selective nature of rejection. In competitive terms, the cost of rejection may grow through time as a knowledge base matures and application spreads among innovating Nation-States. Similarly, benefits of rejection, *e.g.*, maintaining traditional cultural values and life ways, may decline overtime due to trade and exchange with innovating States. An example is suppression of ‘rock n’roll’ by communist governments during the Cold War which proved untenable as radio broadcasts from and trade with the West grew.

14.4.2 As Verb

1. While the opportunity cost of acceptance or rejection may be straight forward with knowledge as Noun, as a Verb it is not. Knowing by Science and knowing by Design - by reduction and construction - are compliments not substitutes or opposites. Each contains the seed of the other like the Chinese “*t’ai chi t’u*” - a white dot on black, a black dot on white.
2. At any point in time a Nation-State may, however, enjoy a competitive advantage in one or the other. If so, then the question becomes whether to exploit this advantage, balance it or, at the extreme, initiate an epistemic revolution. In Japan, such a revolution was formalized with the Meiji constitution of 1889 marking the transformation of the Japanese economy and society from one dedicated to Design rooted in the organic patterns of nature, *i.e.*, works of aesthetic intelligence, to works of technological intelligence. Until then development and use of firearms was banned in Japan. The Japanese navy, however, defeated the imperial Russian fleet just sixteen years later in 1905 and Japan joined the select group of industrialized nations even gaining colonies such as Taiwan and Korea.
3. That the white dot remains part of the black, even after an epistemic revolution, is suggested by the fact that Japan continues to enjoy a comparative advantage in design of both works of technological and aesthetic intelligence but a disadvantage in the pure sciences due, as has been argued, to the nature of the Japanese language itself ([Kawasaki 2002](#)). Similarly, Italy enjoys a comparative advantage in works of aesthetic intelligence, but exhibits poor performance with respect to organizational technology (Galbraith 1983).

14.4.3 As Form

1. Knowledge does not exist in a vacuum. As an input, it is fixed in material form. Personal & tacit knowledge is embodied as neuronal bundles of memories and trained reflexes of nerve and muscle available on the market as personal & tacit labour. Codified knowledge is

fixed in a communications media while tooled knowledge is embodied in a functioning material matrix. Together, as inputs, they are available on the market as codified & tooled capital, *i.e.*, frozen knowledge. Similarly, with the appropriate knowledge, environmental features become available on the market as toolable natural resources.

2. The Person, however, is duplex, *i.e.*, it is the ultimate input to and output of a knowledge-based economy. Accordingly, a central pillar of any knowledge-based competitiveness strategy must be the Person. Such centrality places education and training in the policy cross-hairs but what kind of education and training? Should it stress Science or Design or a blend? Furthermore, the Person carries the customs and traditions of one's Nation-State (Schlicht 1998). Such patterns may or may not be supportive of a self-regulating market. Accordingly, a break, at the individual level, with customary practice may be required if a Nation-State is to become globally competitive. And, is the cost worth it, in terms of fitness, in the short- and long-run?

3. Accepting the centrality of the Person, the next question is should a Nation-State specialize in Code or Tools or a blend? Again, an assessment of the national knowledge endowment is required. Does a nation have a comparative advantage in Code, *e.g.*, copyrights, designs, patents and trademarks? If so, the flow of IPR royalties should be a significant source of national income. This raises, however, questions about the adequacy of the System of National Accounts reporting IPR income streams ([UN Statistics Office](#)). My reading is that decades of down-sizing government has not spared national statistical bureaux. As a result, data collection, especially regarding IPR revenue streams, is problematic at best, even in the most statistically advanced nations such as the United States. This limits mathematical analysis and biases public and private policy towards that which can be counted, *i.e.*, traditional outputs of the primary, secondary and tertiary sectors. What I call the 'quaternary sector' of the economy (Chartrand 1990) consists of royalty payments for copyrights, industrial designs, know-how, patents, trademarks and trade secrets plus *sui generis* rights. These, however, are not, in my opinion, adequately accounted for in the system of national accounts.

4. Alternatively, a nation may enjoy an advantage in production of Tools or works of technological intelligence. The split between production of Code and Tools increasingly defines the relationship between the First, Second (China) and Third Worlds. What is called 'off shore production' for First World firms generally involves, initially, manufacturing of standardized products, *e.g.*, cars, hats, scarves, television sets and personal computers. Experience in production of standardized goods, however, offers, the opportunity for learning that potentially

can shift a nation from Second or Third to First World status, *e.g.*, South Korea became the 29th member country of the OECD in December 1996.

5. There is, however, an arguable and generally unrecognized ‘fitness’ limit to the degree of specialization and division of labour afforded by the economic theory of comparative advantage. In the short-run such advantages enhance fitness. In the long-run, however, changes in the environment may turn advantages to ashes. Recent experience with the banning of Canadian and American beef products in international markets due to isolated cases of BSE as well as current discussion about the impact of a possible global avian flu pandemic ([Osterholm 2005](#)) highlight how fragile the global economy remains. If a Nation-State does not retain some minimal redundancy in its primary, secondary and tertiary industries then environmental change may cause it to quickly melt off the heights of its fitness landscape and it may not survive the fall.

14.4.4 As Content

1. Having sketched out the comparative advantage of knowledge as a noun, verb and form, there remain advantages associated with the content of a national knowledge endowment expressed by a unique set of qubits, *i.e.*, four-fold knowledge units. I will consider the six qubits so far identified by discipline: etymology (WIT), psychology (PSI), epistemology/pedagogy (EPI/PED), law (IPR) and economics (FLX). At this time, I can only consider them individually and must leave any advantages associated with their collective interaction for future study.

14.4.4.1 Etymology

1. The WIT is a qubitic or four-fold measure of knowing in the English language. There are four meanings – to know by the Senses, Mind, Doing, and/or Experience. In other languages there are other senses of ‘to know’ that can be expressed in English only with great difficulty, if at all. The Logical Positivists of Vienna and the Philosophical or Logical Atomism of Bertrand Russell (Kauffman 2000, 50) attempted to overcome this problem by restricting themselves to the language of mathematics. Mathematics, however, is a subset of language, not the other way around. In the Anglosphere this, in turn, led to the Analytic Philosophy of Ryle (1949, 1968) for whom all knowing is language. Similarly, English, and other Western European languages use Platonic idealized nouns not found in all major languages, *e.g.*, Japanese ([Kawasaki 2002](#)). These etymological differences appear to have competitiveness implications. The most obvious is the comparative advantage of Anglosphere Nation-States whose entire population operates primarily in the international language of science, commerce and computing – English.

2. In the pre-global market prior to 1995 for most Nation-States virtually all knowledge was expressed in a single national language. Bilingual and multilingual Nation-States struggled to maintain political coherence, *e.g.*, Belgium, Canada and India. With the arrival of the global knowledge-based economy and the coincidental ascendance of English as the language of international commerce, computing and science most States, excepting those of the Anglosphere, had no choice but to become functionally bilingual. Knowledge of English is now a critical global asset. Anglosphere countries therefore enjoy a comparative advantage, one, however, that they tend to take for granted.

3. While all Western European cultures inherited an epistemic hierarchy from the ancient Greeks placing the Liberal Arts (knowing by the mind) above the Mechanical Arts (knowing by the doing and senses), the etymological economy of English has, arguably, produced its extreme expression in the aphorism: ‘Gentlemen don’t work with their hands’. This became a *cause célèbre* in the 1970s known as the ‘British disease’ that was arguably cured by Margaret Thatcher (Wiener 1981). By contrast, in Germany, a nation noted for its manufacturing acumen, the distinction between knowing by the senses and knowing by the mind is represented by two separate verbs *kennen* and *wissen*. As previously observed this has led to a striking contrast between the apprenticeship systems of Canada and Germany (Economic Council 1992) as well as separate and distinct traditions of academic and technical universities in German which has never taken root in the Anglosphere.

4. The relevant WIT policy question is what is the preferred national mix of to know by the senses, mind, doing or experience? Which enhances fitness best? Should policy heighten sensual awareness to foster the Pleasure Industries and which – sports, sex, gambling, food or drugs? Alternatively, should policy cultivate knowing by the mind? Should it foster hands-on knowing by doing? Should the State strive to diversify and broaden the population’s skill set and enhance redundancy of function so each individual can play many roles? Should it capture and codify the experience of the older generation, *e.g.*, expert systems? Should retiring employees be rewarded for formalizing experiential or personal & tacit knowledge and encouraged to transmit it to younger workers by demonstration or other means? Is this the meaning of ‘mentoring’? How much should be codified and/or otherwise communicated? Each question involves a choice; each choice is an opportunity cost relative to relevant rivals.

14.4.4.2 Psychology

1. The PSI is a qubitic measure of psychological ways of knowing including Reason, Revelation, Sentiment and Sensation. In each individual, all four function. Like quarks, they do

not exist alone. There are no free faculties. They exist together uniquely entangled as the ‘self-awareness’, ‘consciousness’, ‘knowing’, ‘mind’ or ‘wit’ of the individual human being. This uniqueness colours use and interaction of each faculty as a power of the mind.

2. Invoking circular causality, if there is a human want, need or desire ‘to know’ through Reason, Revelation, Sentiment or Sensation then there will be industries producing goods and services to satisfy such needs. Such industries will exist in every Nation-State but some countries will enjoy a comparative advantage in one or another. I will review each and offer examples.

3. The human want, need or desire for Reason, *i.e.*, ‘reasoned’, ‘calculated’ or ‘reductive’ knowledge, finds satisfaction through the Science Industry inclusive of the natural and engineering as well as the social sciences to the degree that they rely on calculatory rationalism. In the 20th century the United States established preeminence in the Science Industries including computing. This is reflected in its ‘ivy league’ graduate school system that attracts the best and the brightest scientific minds from around the world (personal & tacit knowledge); as world leader in publication of scientific research papers (codified knowledge); and, in the design and development of scientific instruments (tooled knowledge) (Baird 2004). With respect to codified scientific knowledge, at least, its preeminence may be slipping as the European Union is accelerating its output, threatening U.S. dominance (Pistoi 2002).

4. The human want, need or desire for Revelation is satisfied through the Spiritual Industry inclusive of religion and myriad psychic movements and communities as well as ‘self-help’ groups. To put it another way, from an economic perspective God is real and means very big business. Globally, Saudi Arabia, as custodian of the two holiest Islamic sites – Mecca and Medina, is an example of a nation with a comparative advantage in Revelation, as is Italy and Israel.

5. The human want, need or desire for Sentiment defined as “an opinion or view as to what is right or agreeable” is satisfied through the Arts Industry inclusive of the amateur, applied, entertainment, fine and heritage arts in all media of expression, *i.e.*, the literary, media, performing and visual arts (Chartrand 2000). Art provides the technology of the heart; it manages and manipulates Sentiment. Italy is an example of a nation with an established comparative advantage in the Arts. Arguably, Milan is the design capital of the world. France and Japan also rely heavily on aesthetic design. Similarly, England has successfully branded itself as a cultural power. Thus the former Arts Council of Great Britain once ran a marketing campaign that read: “What sunshine is to Florida, theatre is to London!” U.S. dominance of the

media arts – motion pictures, television, music, *etc.* – is well known and, after defense, the largest American export (*The Economist.*, March 11, 1989: 65-66). Arguably, the Arts Industry is the largest sector of final consumer demand for knowledge outputs. Education is arguably the largest user of intermediate or producer knowledge outputs.

6. The human want, need or desire to know Sensation is satisfied through the Pleasure Industry inclusive of ‘sex, drugs and rock’n roll’ as well as gaming, leisure spas, sports, food and tourism. At present, the Netherlands, with its relatively permissive sex and drug laws compared to the Anglosphere, arguably, enjoys a comparative advantage as does Thailand with its Buddhist tolerance of sex and Monaco with respect to gambling.

7. From an economics perspective what is important is whether a faculty generates human wants, needs and desires to know that producers can satisfy for a profit. Again, unlike aesthetics, epistemology and science, economics admits no *a priori* moral limitations. All the human senses – near and far – are admitted in a global knowledge-based economy.

14.4.4.3 *Epistemology & Pedagogy*

1. The EPI is a qubitic measure of a nation’s pragmatic epistemology. These include the Natural & Engineering Sciences (NES), the Humanities & Social Sciences (HSS), the Arts (literary, media, performing and visual), and the Practices or self-regulating professions. In brief, the NES generate knowledge about the physical world. In application, they produce physical technology to manipulate matter and energy to satisfy human want, needs and desires. The HSS generate knowledge about being human – individual and collective in families, communities, firms and Nation-States. When applied, they produce organizational technology, *i.e.*, the ability to shape and mold human institutions and societies. The Arts generate knowledge about the human heart and emotion. In application, they produce aesthetic or design technology, *i.e.*, the ability to manipulate emotion providing a ‘technology of the heart’. The Practices apply knowledge to answer practical and pressing problems of daily human life, *e.g.*, death and taxes.

2. From a competitiveness perspective, a critical factor is that each Nation-State has culturally and historically differentiated pedagogic and licensing practices for the knowledge domains and practices. Globally, national pedagogic complexes tend to be patterned after models developed in influential countries such as France, Germany, Great Britain, and the United States. In some cases, such as France and Germany, these complexes are directly administered by State agencies. In others, such as Britain, Canada and the United States, they

are legally, if not financially, independent of the State. Such national differences exist in all knowledge domains and practices at all levels of education – primary, secondary and tertiary. These differences are relevant not just with respect to domestic performance but also in the growing and increasingly competitive field of international higher education. Foreign students represent an increasingly important revenue source for educational institutions in many First World countries including Canada (Chartrand October 1992; May 1993).

3. Beyond the export competitiveness of the pedagogic system, *i.e.*, attracting foreign students, each country may or may not enjoy a comparative advantage *vis-à-vis* relevant rivals at one or more levels of a domain/practice, discipline, sub-discipline and specialty. This quartet constitutes the pedagogic knowledge qubit PED. The United States, for example, has a comparative advantage at the graduate and post-graduate levels. In effect, a National Innovation System is constructed by selecting specific knowledge domains and practices (EPI) to be preferentially encouraged at a specific level of concentration, *i.e.*, disciplinary, sub-disciplinary and specialty (PED). Each Nation-State identifies its comparative advantage and networks educational institutions, private enterprise and government agencies to commercially exploit new knowledge. To date, the NIS has been restricted to the NES. There is, however, no reason why it cannot be extended to other knowledge domains and practices. Informally, national cultural policy in the Arts corresponds to NIS in the Sciences. The Practices, with the notable exceptions of medicine and related engineering, have not, however, been the subject of NIS. Accounting and legal praxis are applied to develop NIS development. They have not, however, been subjected to comparative advantage analysis, nor networked into NIS nor held accountable for their contributions – positive and negative – to competitiveness and/or fitness.

14.4.4.4 Law

1. The IPR is a qubitic measure of the privatization of knowledge as legal property. Intellectual property rights are granted to new knowledge fixed in a material matrix for a limited time. The matrix may be utilitarian as with patents & designs; it may be non-utilitarian as with copyrights & trademarks; or it may be a person – natural or legal – as with trade secrets and know-how. All other knowledge (new and old) fall into the public domain that constitutes the bulk of the national knowledge-base.

2. *Sui generis* or ‘one-off’ rights may be fixed in any matrix and are usually created by selecting from and mixing the bundle of rights collectively constituting traditional IPRs. In reality, however, each national intellectual property regime is *sui generis* in that it is the unique cultural product of the distinctive legal history of a Nation-State. This is one reason why

intellectual property rights are subject only to ‘national treatment’ rather than harmonization under the TRIPS Agreement of the WTO. Such differences serve not only to distinguish one Nation-State from another but also provide an opportunity for competitive advantage in a global knowledge-based economy (Paquet 1990).

3. International competitiveness, since the time of Adam Smith, has involved the division and specialization of labour married to comparative advantage which is a concept introduced by Smith’s successor David Ricardo (Blaug 1968, 131). Market forces direct entrepreneurial activity, and, ideally, there is no government involvement in the economy. Given that knowledge as a marketable product can only exist through government action, this traditional strategy is inadequate in a global knowledge-based economy. An appropriate strategy can, however, be developed from the policy paradigm of another of Smith’s contemporaries – the French Physiocrats.

4. Behind the Gallic façade of *laissez faire* and *laissez passer*, there were deeper policy implications, implications never realized because of the French Revolution. First, unlike classical economists such as Smith and Ricardo, the Physiocrats accepted government as an active and productive agent in the economy. Like Polanyi’s self-regulating market, Smith’s market was spontaneous and autonomous; that of the Physiocrats became so, however, only after having been carefully and institutionally designed by government to direct resources towards attainment of national objectives (Samuels 1962, 159).

5. The nature of Physiocratic public intervention is radically different from Marxist ownership of the means of production and Keynesian management of aggregate demand. Accepting that private property and self-interest were the drivers of economic growth and development, the Physiocrats reached beneath the surface of the *laissez faire, laissez passer* marketplace. They reached down to the legal foundations of capitalism (Commons 1924) to manipulate the nature of property rights themselves. For the Physiocrats, “the public interest is manifest in the continuing modification or reconstitution of the bundle of rights that comprise private property at any given time (Samuels 1962, 161).

6. In effect, the Physiocrats wanted to load the dice to raise the commanding heights of the national economy. They wanted to consciously manipulate capitalist self-interest – accumulation of marketable property – to foster and promote the economic growth and development of the nation. The Physiocrats thus viewed property rights as instruments of economic policy. They also saw them as providing the foundation of the economy itself defining what is bought and sold, how and where. Accordingly, the Physiocrats:

implicitly recognize that the basic economic institutions (the organization of economy) are legal in character; that law is an instrument for the attainment of economic objectives and that economy is an object of legal control (Samuels 1962, 162).

7. In summary, the Physiocratic policy paradigm is made up of an objective, strategy, tactics and logistics including:

- (a) the objective being the competitiveness of the nation, absolutely and relatively, to rival states;
- (b) the strategic choice of a core sector which contributes most to attainment of that objective;
- (c) development of tactical instruments in the form of property rights and manipulation of the legal structure to direct individual and collective action in favour of the core sector; and,
- (d) logistical deployment of these instruments into a free wheeling, private property, *laissez faire, laissez passer* marketplace.

8. Given the degrees of freedom under national treatment, the Physiocratic policy paradigm offers a succinct national competitiveness strategy for a global knowledge-based economy. It begins with the strategic choice of knowledge then tactical development of an IPR regime that directs individual and collective action to favour development of the national knowledge-base and finally logistical deployment of the resulting legal regime into a *laissez faire, laissez passer* marketplace. This policy paradigm accommodates: (i) coherent development of a national IPR regime rather than the piecemeal process that has characterized copyright and patent reform in most Nation-States over the last twenty years; and, (ii) the institution-building and networking required by a NIS.

14.4.4.5 Economics

1. The FLX (pronounced 'flex') is a qubitic measure of economic knowing, specifically of technological change. In the Standard Model, technological change refers to the impact of new knowledge on the production function of a firm or nation. Such new knowledge may be: disembodied or systemic to the economy such as general improvements in communications or transportation. It may be embodied in a specific piece of equipment such as the transistor in a transistor radio. It may be endogenous *i.e.*, developed internally to a firm or nation; and/or, exogenous, *i.e.*, developed externally to the firm or nation.

2. From a competitiveness perspective, technological change has two dimensions: invention and innovation. Roughly speaking invention involves creation of new knowledge and

innovation involves its application. The first step is to determine if a Nation-State enjoys a comparative advantage in invention or innovation. Once this is determined, then the strategic decision must be made to pursue and enhance this advantage, balance it, or engage in an epistemic revolution.

3. The fax machine is a case in point. Arguably the modern fax machine was invented in the U.S. It was, however, successfully innovated and brought to mass market first in Japan. To paraphrase the *1992 World Competitiveness Report*: most inventions do not fail because they are ill conceived but because they are badly innovated. Competitive organizations have correctly mastered innovation and the management processes linked to it ([WEF 1992](#)).

4. Arguably it was the Japanese language that led to mass market innovation. Before the 1980s, business communication relied on (other than telephone and ‘snail’ mail) the ‘telex’ machine to electronically transmit information using an alphanumeric keyboard. In Japan, however, kanji script is pictographic and some 500 characters are required for basic written communication. Alphanumeric keyboards could not accommodate (at the time) the Japanese alphabet. The fax machine, however, allowed handwritten pictographic messages to be sent with relative ease. In the phonetic United States, by contrast, telex was an efficient communications medium and the fax machine was reserved only for occasions when sending pictures quickly was required for business or other purposes, *e.g.*, pictures of wanted criminals. There was no apparent need for mass market fax machines in the U.S. Thus a Japanese linguistic disadvantage turned into a marketing triumph.

5. Development of a national FLX competitiveness strategy begins with a national comparative advantage assessment of the sources and types of technological change. Does the nation endogenously generate a significant share of new knowledge relative to rivals? If yes, then a relatively restrictive IPR regime is in order to protect national knowledge assets. If not, then a relatively lax IPR regime will allow easier access to exogenously developed knowledge. A lax intellectual property regime is also appropriate if a nation is comparatively adept at embodying or innovating new knowledge. Conversely, if it is not adept, then a tighter intellectual property regime is in order. In the case of a lax IPR regime the public domain will grow more rapidly; a more restrictive regime will slow its growth.

6. A national FLX competitiveness strategy must, however, not only address knowledge as a factor of production or input but also as a final good and service. Just as branding has been achieved by some Nation-States with respect to cultural or environmental factors, it can also be achieved with respect to knowledge. Under GATT, Nation-States can and do deny access to

knowledge considered immoral or threatening to the cultural sovereignty of the nation. Other Nation-States, however, may consider the exact same knowledge as acceptable – legally if not morally – and permit or even facilitate access. Such differences, in effect, create knowledge havens where access to forbidden knowledge is available just across the border. Thus internet cafes in a foreign country may offer the ‘knowledge tourist’ satisfaction of his or her knowledge wants, needs and desires that cannot be satisfied at home.

14.4.5 Governance

1. Ideally, Government is the institutional incarnation of ‘We, the People’ or, in my terms, of ‘We, the Person’ as the ultimate input and output of a knowledge-based economy. Only the natural person can know and therefore all knowledge is ultimately personal & tacit. In this sense, the Person is a Noun acting as “a centre of force” containing knowledge (Catholic Encyclopedia, *Noun*, 1911). The natural person is, however, also a Verb, a social solitaire (Bronowski 1973). It is the ability of the Person to share and exchange knowledge with others that permits social organization up to its institutional apex – Government. As such, Government is the quintessence of the knowledge-based economy. And, in this sense, a knowledge-based *is* a political economy, *i.e.*, political decisions play a central role in the satisfaction of the human want, need and desire to know, subject to limited means. Put another way, no Government, no knowledge-based economy.

2. At each level of knowledge – as noun, verb, form and content - Government plays five distinct roles – as custodian, facilitator, patron, architect and/or engineer of the national knowledge-base. Each Government determines its own particular blend. Choice, however, entails opportunity costs.

3. I will now sketch out the principle choices associated with each role. It is only a sketch. It is, again, illustrative, not a detailed evaluation. It does, however, provide examples and additional tools of thought that hopefully will thicken public and private policy debate and discussion.

4. As Custodian of the national knowledge-base, Government is concerned with its preservation and transmission to future generations, *i.e.*, it is concerned with patrimony and the survival of the nation. The continuity of knowledge is in fact one function of any human community. This function is generally performed by national archives, libraries and museums and involves opportunity costs. Faced with limited means, Government must decide what is and what is not worthy of preservation. This is a pressing issue for national archives and libraries

faced with acidic-based paper. Books, newspapers, periodicals and other written records fixed in this matrix are literally disintegrating in libraries and archives around the world (*The Economist*, February 27, 1987: B-1). Government as custodian is also, however, concerned with prohibiting the growth and development of forbidden knowledge. Over time, however, what is forbidden often changes. Accordingly, prohibition may leave future generations without what they may consider acceptable, desirable or even essential knowledge, *e.g.*, fetal tissue technology.

5. As Facilitator of the national knowledge-base, Government is concerned with fostering knowledge production through exemption from taxation. Government relies on the preferences and tastes of corporate, foundation and individual donors. The policy dynamic is random reflecting the changing tastes of private donors. The Facilitator is also potentially subject to abuse, *e.g.*, research & development tax credits in Canada (Auditor-General 1984, 3.34-3.49). Nonetheless, the Facilitator role offers Government the opportunity to promote a ‘creativity haven’, *i.e.*, a jurisdiction in which knowledge workers want to live. Exemption from income tax of copyright income earned by resident artists (not legal persons) in the Republic of Ireland (Eire) is an example relevant to all knowledge domains.

6. As Patron of the national knowledge-base, Government is concerned with promoting production of knowledge through endowing arm’s length institutions. Such institutions generally direct funding according to peer evaluation. In Canada, for example, during the last decade the federal government of Canada has endowed a number of quasi-public foundations to support knowledge production, *e.g.*, “Canada Health Infoway Inc., received \$500 million from the federal government; others have received multiple payments amounting to, for example, \$300 million to Genome Canada and \$250 million for the Green Municipal Funds” (Auditor-General of Canada 2002, 1.9). In the past foundations, endowments or grant-giving councils were essentially involved in the production of knowledge for knowledge sake. Today, however, as part of the national innovation strategy many of the new foundations are concerned with ‘knowledge for profit’. This means that commercial confidentiality veils many of their activities from public scrutiny. This, in turn, raises serious questions about the accountability of private interests serving the public purpose, *i.e.*, *Government by Moonlight: The Hybrid Parts of the State* (Birkinshaw, Harden and Lewis 1990)

7. As Facilitator and Patron, Government transfers its spending to others allowing them to decide what knowledge to promote and develop. As Architect, however, Government is concerned with the direct application of its spending power as well as its legislative authority to achieve specific objectives. It funds knowledge production and conservation through ministries,

departments and specialized agencies such as national statistics bureaux. Bureaucrats, in effect, make decisions on behalf of their political masters.

8. The most recent example of the Architect is design and development of national innovation systems (NIS). In these systems nonprofit academic institutions partner with government and private for-profit actors to create networks of specialized research centres in priority domains, disciplines, sub-disciplines and specialties (OECD 1997). Such centres are intended to facilitate commercial exploitation of new knowledge and enhance the competitiveness of the nation. As always, there are opportunity costs. Thus almost since their inception, certain costs and strains with respect to NIS have become apparent. In many knowledge sectors, *e.g.*, electronics (Patel & Pavitt 1998), such partnerships necessarily involve multinational or transnational corporations whose attachment to any Nation-State is secondary to profit. Accordingly, whether or not new knowledge can be commercially exploited to the benefit of a Nation-State is problematic.

14. It is here that ‘tacit’ versus ‘codified’ knowledge question enters the public policy debate (Cowan, David & Foray 2000). If new knowledge is embodied as the trained reflexes of a Person it cannot be easily appropriated. If it is codified, however, then it can be much more easily exploited by others. For example, if Agriculture Canada in collaboration with its NIS partners successfully fosters new knowledge about canola that is tacit in nature then Canada can internalize virtually all benefits. On the other hand, if it is codified then participating multinationals with access to the knowledge can apply it where and when it serves their purposes which are not necessarily those of Canada. To prevent the escape of NIS generated knowledge becomes a serious enforcement problem for Government.

10. While as Custodian, Facilitator, Patron and Architect Government relies principally on fiscal policy, *i.e.*, tax and spend, as Engineer it acts as owner. It exercises its power through many different forms and types of legal frameworks, *e.g.*, broadcast licensing, copyright and patent deposit requirements, security & exchange legislation, IPRs, spectrum allocation, taxation and international trade agreements including any health, safety and morals clauses contained therein. With respect to trade agreements, it is important to note that only the Nation-State can sign internationally binding treaties and that they are the only institutions that, according to at least some observers, “can curb the inherent excesses of global capitalism” (Gwyn 1995, 266). In effect, Government sets the rules of the game for all other autonomous agents in the knowledge-based economy.

14.5 Competitive Afterthoughts

1. Competitiveness or fitness? Which is the more appropriate metaphor for the success of a Nation-State in a global knowledge-based economy? Each carries ideological baggage. The competitiveness of sports brings the sense of win/lose against an opponent and winner takes all. The fitness of biology brings the sense of survival/reproduction in an environment increasing enframed and enabled by human technology and populated by many more symbionts than predators. The first is hostile and aggressive; the later, cooperative and coevolutionary.
2. In effect, most Nation-States, especially smaller ones, have opted for coevolution with other Nation-States in the guise of trading blocs such as NAFTA and the European Union. Division and specialization of knowledge remains limited by the extent of the market and most Nation-States are not large enough in population and/or natural resources to specialize in everything. They can no longer independently reproduce themselves.
3. Environmentally, it is also critical to recognize that human technology, transcendent to all Nation-States, is enframing and enabling the entire planet – the geosphere, biosphere and even the noösphere, *e.g.*, the WWW – making it ready at hand to satisfy human wants, needs and desires. This physical technology, rooted in the early natural & engineering science success of the West, has successfully been adopted by the East, *e.g.*, China, India, Japan, Malaysia, Singapore, South Korea and Taiwan. How it is applied, however, depends not on knowledge from the NES but rather from the HSS and the Arts, *i.e.*, values and tastes. Such ‘soft knowledge’ will play, I believe, an increasingly important role in determining the fitness of Nation-States. As physical technology becomes ubiquitously available to all, it will be value and taste differences that will determine fitness to survive and reproduce.
4. In this regard, the production function of a knowledge-based economy is based on a critical and arguably provable assumption – all knowledge is ultimately personal & tacit and is the possession of a natural Person. In effect, this humanizes labour yielding a labour theory of knowledge and its corollary, the knowledge theory of capital. Codified and tooled knowledge only have meaning or function through the mediation of a natural Person. Accordingly, there are two critical questions each Nation-State must answer. First, can we afford to waste human resources? And second, how do we get the most out of the individual? These are questions of motivation not addressed by the billiard ball causality of traditional physics but rather by the HSS and the Arts and, perhaps, also by biology. These are questions invoking *causality by purpose* which arguably is a primary function of the Nation-State. This epistemic shift reflects, I believe, a critical facet of contemporary ideological evolution.

15.0 CONCLUSIONS

1. My objective was to deepen and thicken public and private policy debate about the competitiveness of nations in a global knowledge-based economy. To do so, I first demonstrated the inadequacies of the Standard Model of economics, the last ideology standing after the Market-Marx Wars (Chapter 2). Second, I developed a methodology (Trans-Disciplinary Induction) to acquire ‘knowledge about knowledge’ (Chapter 3). In the process, I redefined ‘ideology’ as the search for commensurable sets or systems of ideas (in this case about knowledge) shared across different knowledge domains, practices, disciplines, sub-disciplines and specialities of thought.
2. Third, I progressively defined knowledge in greater depth and detail as noun (Chapter 4), verb (Chapter 5), form (Chapter 6) and content (Chapter 7) as defined in etymology (Chapter 8), psychology (Chapter 9); epistemology & pedagogy (Chapter 10); law (Chapter 11); and, economics (Chapter 12). Fourth, I established the origins and nature of the Nation-State, the shifting sands of sovereignty on which it stands and the complimentary roles it plays as curator, facilitator, patron, architect and engineer of the national knowledge-base (Chapter 13). Fifth, I examined the competitiveness of nations with respect to a production function (Exhibit 2) in which all inputs, outputs and coefficients are defined in terms of knowledge (Chapter 14). In the process, I demonstrated that ‘competitiveness’, as in winning against rivals, is inadequate because it fails to account for the role of symbionts and environmental change. Accordingly, I proposed the concept of ‘fitness’ as a more appropriate criterion. I then sketched out comparative advantage with respect to an initial national knowledge endowment (Exhibit 3).
3. In conclusion, I offer three closing comments about knowledge, the production function and the Nation-State in a global knowledge-based economy.

15.1 Knowledge

1. In summary, knowledge takes three forms: personal & tacit, codified and tooled. These are expressed as economic inputs to the production function as codified & tooled capital, personal & tacit labour and toolable natural resources. As final outputs knowledge takes form as the Person, Code and Tool. Ultimately, however, all knowledge is personal & tacit having

meaning or function only with the mediation of the natural Person. This is why Michael Polanyi entitled his masterwork: *Personal Knowledge: Towards a Post-Critical Philosophy* (1962a).

2. The natural Person, however, is dyadic. On the one hand, one is a biological entity, an autonomous agent. One's knowledge, however limited, embraces the geosphere (physics and chemistry), the biosphere (biology) and the noösphere (ideology). Knowledge is gained through the five physical senses as raw sensation then integrated and interpreted by the mind as perception. Knowledge is thus initially carnal then emotional, intellectual and spiritual. The human being is knowledge incarnate, the wise earth, *i.e.*, *homo sapiens*.

3. On the other hand, the Person is a social entity (a co-evolving agent) governed by collective laws which, for example, convert new knowledge into marketable property. In the case of codified knowledge, it is fixed in a non-utilitarian matrix carrying human-readable, semiotic meaning to a distant human mind and protected by copyrights and trademarks. In the case of tooled knowledge, it is fixed in a utilitarian matrix carrying function (hard-tooled knowledge) or machine-readable code (soft-tooled knowledge) and protected by patents and registered industrial designs. In the case of personal & tacit knowledge, it is fixed in neuronal bundles as memories and muscle & nerve as reflexes and protected by trade secrets and 'know-how'.

4. Marketable knowledge in the private domain, however, constitutes but a tributary to a vast public domain of knowledge free and available to all to satisfy each Person's wants, needs and desires. The public domain fuels the adjacent possible, one step, one connexion away from a nation's existing knowledge endowment. This endowment thus consists of two temporally overlapping domains – the public and private. The distinction is justified, however, only as a reward for creativity by a Person – natural or legal. This reward is justified so that the public domain may grow faster than otherwise possible given the free-rider problem of knowledge. The public domain, in the tradition of the Republican Revolution, is also the foundation of critical political liberties and freedoms such as freedom of the press and freedom of expression by the individual.

5. There are three additional conclusions I wish to draw about knowledge. The first concerns its causal hierarchy, *i.e.*, how we acquire knowledge in the different spheres. The second concerns one cost of knowledge - the problem of dirty hands. The third involves examples of ideological commensurability across knowledge domains, practices and disciplines of thought.

15.1.1 Causal Hierarchies

1. There are four traditional kinds of causality: material, formal, efficient and final. Since the initial Scientific Revolution of the 17th century, knowledge about the geosphere – physics and chemistry - has very effectively been acquired using a combination of material and efficient causes, or ‘when-then’ causality (Greene & Depew 2000). Ideologically justified by Robert Boyle, mechanical causality formally freed knowledge of the geosphere from subordination to Church and State with the royal charter to *The Royal Society of London for the Improvement of Natural Knowledge* in 1660. The mechanical or billiard ball causality of the new experimental or natural philosophy, expressed in Newton’s calculus, gradually spread as a distinct episteme to moral philosophy where in the 19th century it spawned a new species - the social sciences.

2. Knowledge of the biosphere, however, especially of human nature, remained outside the orb of mechanical causality and subject to Church and State. It was a hundred years after the initial Scientific Revolution that Kant, in the late 18th century, at least partially liberated biology. Relying on a combination of formal and final causes, Kant explained biological entities as subject to a ‘natural purpose’ that required no ongoing divine intervention or explanation. In effect, his teleology is what I call ‘causality by purpose’. He demonstrated its operation, however, not only in biology but also, in modified form, in the Arts and Technology. At about the same time, Baumgarten liberated the Arts through a new philosophy – aesthetics – which subsequently, in the early 20th century, gave birth to gestalt psychology, the impact of which will be more fully described below. In all cases, however, knowledge derived through formal and final causes, *i.e.*, causality by purpose, is judged inferior to mechanical causality.

3. Biology thus remained a descriptive science of the taxonomies and forms of living things. It was not a logical or mathematical science until Darwin, in the mid-19th century, introduced ‘natural selection’ as the mechanism of evolution. In effect, it is the ‘natural purpose’ of all organic entities including humanity – no God subsequently required. From this insight biological statistics began applying the law of large numbers and probability rather than calculus as its mathematical foundation.

4. In the late 19th century and early twentieth century, however, the nature of knowledge about the geosphere itself began to change. There was, in effect, a second Scientific Revolution. The foundation was no longer seen as consisting of indivisible billiard balls but rather of probabilistic quantum states. The law of large numbers and probability rather than calculus then became the mathematical foundation of both physics and chemistry. It was this tectonic shift in

knowledge that led Edgar Zilsel to part ways with the Vienna Circle and Logical or Empirical Positivism as well as Bertrand Russell and Logical Atomism.

the so-called law of large numbers... states what at first glance seems to be a rather truistic statement of probability theory, namely that “with a large number of repeated throws of a chance game... the relative frequency almost equals the mathematical probability.” Nature, however, could be rather different. She could produce frequencies quite different from the expected result. It is therefore not at all trivial to ask why the law of large numbers is applicable at all. Zilsel construed this problem as being part of a wider one: how can rational mathematical constructions apply to a vague and irrational nature? This is what Zilsel termed ‘the application problem’. (Raven & Krohn 2000, xxxix)

5. Furthermore, it is the increasing sensitivity of scientific instruments that provide the numbers necessary to probabilistically generate what Idhe (1991) calls ‘Instrumental Realism’. This is especially true in the emerging science of genomics where the concept of life is rapidly changing from a mystery into ‘testable’ probabilistic equations of molecular biology and organic chemistry measured and manipulated without human mediation by increasingly sophisticated instruments.

6. Arguably in the noösphere all four types of causality are at work. With respect to knowledge, for example, it was demonstrated that the biological need to know (material cause) is pursued through Science by Design (efficient cause) which generates personal & tacit knowledge (formal cause) as new memories and/or reflexes, the content of which (final cause) satisfies a specific human need to know. Similarly in economics, it has been demonstrated that economic inputs are the material cause out of which a thing is made. Economic outputs are the formal cause, *i.e.*, the form or shape of the final thing designed to satisfy consumer needs. The efficient cause or initiating agent is the entrepreneur or firm that makes the thing. And the final cause of economic activity, its end purpose or *teleos*, is profit through the satisfaction of human wants, needs and desires. Arguably, one can therefore identify a causal hierarchy: in the geosphere, material/efficient or *mechanical causation* remains primary at the mesoscopic level; in the biosphere, formal/final or *causality by purpose* still dominates but is rapidly being complimented by an emerging genetic mathematics simulating material and efficient cause; and, in the noösphere, all four are at play in varying combinations and permutations, only some of which, however, can be expressed in mathematical language.

15.1.2 Dirty Hands

1. There is an old adage: Knowledge will set you free but first it will hurt you! With the Cambrian Explosion of knowledge following the initial Scientific Revolution, this adage

arguably applies to all knowledge domains and practices. The perceived misuse of ‘new’ knowledge is known as ‘the problem of dirty hands’. Originally coined to describe physicists spawning the atomic bomb (Fuller 2000), there are lots of dirty hands to go around. Biology suffers from eugenics and its demon child, the Holocaust. Thus behind front page opposition to ‘genetic engineering’ of any kind – GM foods, fetal tissue research, *et al*, lays the specter of the gas chambers and smoke stacks of Auschwitz and the smiling face of the all-knowing biologist.

2. Economics must accept paternity for its own devil spawn, the Market/Marx Wars, which, for half a century, threatened mutually assured nuclear destruction of the human race because of an ideological dispute over private property. Metaphysics and religion similarly must admit responsibility for centuries of practicing ‘burn the body, save the soul’. Ask Joan of Arc about God’s mercy administered at the hands of humanity? Even the Arts must accept responsibility. In Nazi Germany, all modern means of artistic expression - from radio and television to the motion picture - were harnessed in the service of a cause so evil that colour film of the Nuremburg Rallies has never been released to the public by the American Government, which holds negatives and positives in protective custody. What in scratchy black and white is ancient history is, to the modern eye, a symbol of the power of Art to serve evil in living colour. And the ‘Agiprop’ practiced in the Soviet Union under Lenin through his Commissar of Enlightenment arguably consolidated the revolution in the country-side before Stalin took over and displaced it with industrialization and socialist realism. Art is not *summum bonum*, any more than physics. Neither, of course, are the Practices. Eugenics thus engaged Medicine while Enron and related scandals engaged Accountancy leaving both with very dirty hands as well as reduced public respect and authority.

15.1.3 Ideological Commensurability

1. While trans-disciplinary induction (TDI) may technically be more accurate and a politically correct term, ideology, as the search for commensurate systems or sets of ideas, more accurately reflects its results. In my survey of seventeen sub-disciplines plus etymology I uncovered six sets or systems of commensurate ideas at play in two or more disciplines.

2. First, the most important and certainly the most wide spread is ‘gestalt knowing’. Gestalt knowing is an epistemology, or theory of knowledge, found in aesthetics, biology, economics, science and technology. In aesthetics, figure/ground is the accepted way of knowing, or appreciating, a painting or a picture. Our visual system simplifies a scene into a figure on which we focus and a ground which is everything else. In biology, gestalt theory is

implicit in Grene & Depew's view of knowledge as orientation in an environment populated by affordances/invariants. You pay attention to the first accepting the later as given.

3. In the deductive sciences such as economics a similar role is arguably played by assumption/deduction. Having accepted or assumed something as fixed, we focus attention on what conclusions can be deduced or flow from the assumption. Similarly in the philosophy of technology, Heidegger claims that the true essence of technology is 'enframing', a word translated from the German *Ge-stell* (Heidegger 1955, 15) and arguably related to *gestalt* meaning "a 'shape', 'configuration', or 'structure'". In effect, technology enframes our life enabling us to take a given function for granted. This enabling/enframing represents a foreground of getting on with it while taking the background, the hard-tooled knowledge of technology, for granted, *e.g.*, the black box.

4. Finally, in the philosophy of science, Michael Polanyi explicitly claimed to expand gestalt psychology into a theory of knowledge (M. Polanyi Oct.1962, 605). For Polanyi, there is only focal/subsidiary knowing. Without the tacit or subsidiary knowledge of context, focal knowledge has no framework, no meaning. Even Thomas Kuhn's philosophy of science is gestalt knowing. Once a paradigm is fixed then focal attention turns to highly productive 'puzzle solving'. Without a subsidiary and assumed paradigmatic background we have revolutionary, not normal science. What all these disciplines share is a common theory of knowledge flowing from gestalt psychology which derives from aesthetics and, ultimately from the Design Revolution of the Renaissance. Arguably, the experimental method itself can be expressed in gestalt-like terms holding all experimental conditions constant (background) then studying the effect of a change in one variable – cause and effect (figure).

5. Second, the concept of work expressed by Kauffman as 'the constrained release of energy' is also commensurate across many disciplines. This concept applies to a work of aesthetic or technological intelligence which requires the constrained release of energy for its creation or appreciation. In fact it is the constrained release of energy that makes an instrument work. In physics and mechanics 'work' similarly means "the operation of a force [energy] in producing movement or other physical change, esp. as a definitely measurable quantity" (OED, *work*, n, I, 8). In economics, work is labour or "human effort, physical or mental, used to produce goods and services" (Mansfield & Yohe, 2004, A6). Arguably, as the constrained release of energy, work links to Heidegger's technology as enframing us. In this sense, technology stores energy fixed or flowing into physical structures (static or dynamic) enabling us, making this force ready at hand to serve human purpose on demand. As will be seen in more

detail below, technology in this sense includes the absorption, enclosure, internalization or enframing of the natural into an ever expanding human-made environment through construction of ever greater and yet ever more sensitive constraints on the release of energy, *e.g.*, global warming.

6. Critically, however, technology as the enframing effect of human-made constraints on the release of energy must also account for the energetic fact that life lives on the classical/quantum frontier. In the biosphere, this means that one photon can activate a neural response. In the noösphere, this means that threshold effects and avalanches of change may be associated with an apparently marginal release or absorption of energy, *i.e.*, the so-called ‘butterfly effect’. An extreme example is the effect of an electromagnetic pulse (EMP), *e.g.*, by the global detonation of nuclear weapons or a nearby supernova, on the computer age. It would probably become extinct, at least for a time. Old technologies would have to be revived before computer culture could arise again. A less energetic example is a revolutionary tract (how much physical energy did it take to write *The Communist Manifesto*?) that leads to mass conversion of a population and their life ways.

7. Third, there is the concept of the qubit as a four-fold unit of information. As demonstrated, the qubit operates in sub-atomic physics, genomics and analytic psychology. It allows some comparative analysis of otherwise incommensurable forms of knowledge. One can only speculate why the human minds likes to see things in fours. Perhaps the qubit is an artifact of carbon-based life with its chemical valence of four. If life, as we know it, is rooted in the number four then it should not be surprising that as cognitive carbon-based beings we would tend to pattern much of life, rightly or wrongly, including knowledge, using the number four. Such thinking – linking *psyche* to *physis* - was in fact pursued by Carl Jung and Nobel Prize physicist Wolfgang Pauli (Meier, 2001).

8. Finally, there are three related sets of ideas that are shared by biology and economics. These are the division and specialization of labour, natural selection and comparative advantage. Precedence, however, must be given to economics. Kauffman, in his eulogy to the growing diversity and complexity of life, draws on a root planted by Adam Smith (1723-1790) with his observation that the division and specialization of labour is limited by the extent of the market. With respect to natural selection, Darwin himself recognized a debt to economist Thomas Malthus (1766-1834), one of Smith’s immediate successors, and his observation that the food supply grows arithmetically while human population grows exponentially. And Kauffman draws a parallel between survival of the fittest in biology and in economics where the ‘survivor

principle' was coined by 1982 Nobel Prize winning economist George Stigler. The economic principle, however, lacks a determinant mechanism of selection. When asked which firms are successful, Stigler answers those that survive, no matter why. Similarly Kauffman's explanation of mutualism or coevolution in molecular biology is based on the advantages of trade which conceptually links to yet another of Smith's immediate successor, David Ricardo (1772-1823).

15.2 Production Function & the Labour Theory of Knowledge

1. Economics, since before the time of Adam Smith and John Locke, has faced a perennial conundrum (Dooley 2005) regarding its theory of value as distinct from price theory, *i.e.*, market price. If, as Locke argued, natural resources are a gift of nature then the only contributing factor to production is labour and the value of different goods and services should reflect their difference in labour input. Similarly the Austrian school of economics, especially in the work of Bohm-Bawerk (Blaug 1995), believed that capital was, in fact, embodied labour produced by 'round about means of production'. And, of course, Karl Marx considered capital a form of theft from the worker. Arguably, Marshall sided stepped the question by focusing on market price creating a continuing split between the theory of value and price theory. Nonetheless, the labour theory of value lay at the heart of the Market/Marx Wars that threatened human civilization for almost a century and a half.

2. If, however, all knowledge is ultimately personal & tacit and if all factors of production and outputs are forms of knowledge then resolution of the controversy becomes possible (Exhibit 3: Production Function of a Knowledge-Based Economy). Resolution lays in a labour theory of knowledge and its corollary, the knowledge theory of capital. The value of a Person, Code or Tool thus becomes the knowledge contained therein, *i.e.*, the more knowledge, the more added value. Capital, as codified and tooled knowledge, is, however, subject to access restrictions, *i.e.*, property rights, because it is fixed or frozen in a material extra-somatic matrix subject to varying degrees of exclusion, *e.g.*, lock & key or IPRs. Similarly, toolable natural resources take on value only with knowledge of their use and application. Personal & tacit knowledge, on the other hand, is living knowledge that is the exclusive possession of the natural Person. Furthermore, codified and tooled knowledge only take on meaning or function through the mediation of a natural Person, *i.e.*, ultimately all knowledge is personal & tacit. And personal & tacit and codified & tooled knowledge are the ultimate staple commodities in a global knowledge-based economy.

15.3 The Nation-State

1. With respect to the Nation-State I have two concluding thoughts based on the biological motif *cum* Kauffman but prefaced by an observation. The Nation-State is a relatively new and unstable player on the geopolitical scene. It is less than 100 years old reflecting the WWI triumph of the American Republican Revolution of 'We, The People'. Unfortunately, the question of who is 'We' persists as evidenced by the break up of Nation-States like Yugoslavia and the Soviet Union. It is also evidenced by the persistent independence or separatist movements of internal 'nations' in supposedly well-established Nation-States like the U.K., Canada, France and Spain. It is, however, most apparent in Africa where the imprimatur of the United Nations enforces borders of post-colonial Nation-States composed of two or more often hostile ethnic or linguistic nations more related to kin across the border than fellow 'citizens' at home.

2. Nonetheless, the Nation-State is the prime attractor in the noösphere. It is around the Nation-State that most human institutions gravitate – artistic, defense, economic, educational, legal, linguistic, religious, scientific, technological, *etc.* It is also the Nation-State that provides the legal foundation for the knowledge-based economy through intellectual property rights without which such an economy could not exist. Furthermore, only the Nation-State can sign international treaties and belong to the United Nations, WTO, WIPO, *etc.* Other autonomous agents like the individual, private enterprise and professional associations remain ultimately accountable at the level of the Nation-State even if to a 'flag of convenience'.

3. The Nation-State has, however, an ideological Achilles' heel. Whether formally a republic or a legal fiction, *e.g.*, in the constitutional monarchies of the British Commonwealth, its legitimacy ultimately rests on the Republican principle of 'We, The People'. The rights of the Person are paramount except when they clash with those of other individuals. It is at this border line that interpretation of the 'We' and the 'I' sometimes conflict between Nation-States. This is most evident in the ongoing international controversy about 'human rights' in which some Nation-States like China argue in favour of the 'We' at the expense of the 'I' while the United States and others argue in favour of the 'I' at the expense of the 'We'.

4. In addition, the modern Nation-State is a fabric of overlapping temporal gestalten and epistemes. How tightly language weaves together with religious and political threads of a country's history, for example, is critical to its fitness. In many post-colonial Nation-States, for example, professional association at the international level is often more important to the Person than nationality, *e.g.*, the so-called brain drain from developing countries. Given such factors –

separatist movements as well as ethnic, religious and linguistic tensions and the question of human rights - the future of many Nation-States is problematic at best. The effect of striving for comparative advantage in a global economy simply adds to this stress.

15.3.1 Work, Wealth & Membranes

1. As prime attractor, the Nation-State uses the constrained release of energy, *i.e.*, work, to enframe itself in a semi-permeable osmotic membrane separating all that is outside from all that is inside. From outside come imports and from inside out go exports in trade with other Nation-States which, however, continue to compete for public commons such as the oceans. As has been seen, the advantages of trade encourage specialization in whatever activities a Nation-State enjoys comparative advantage. There are, however, opportunity costs associated with unbridled pursuit of comparative advantage. These will be more fully discussed below.

2. Internally, the test becomes how many things does a Nation-State do and in how many does it enjoy a comparative advantage? According to Kauffman, it is the number, diversity and complexity of autonomous agents within the membrane that determine the wealth of nations (Kauffman 1990, 320). Their successful “individuation” (Kauffman 1990, 313), a term associated in my mind more with analytic psychology but which I interpret here to mean specialization of function through coevolution with others, occurs first within the protective membrane of the Nation-State:

wherein individuation of coordinated clusters of ... production processes arise, [and] may be near universal models of minds, knower and known, mutually creating the world they inhabit. (Kauffman 1990, 314)

15.3.2 Fitness Limits

1. Division and specialization of labour is, however, limited by the extent of the market, *i.e.*, by the volume contained within a national membrane. With respect to knowledge this volume or content represents the initial national knowledge endowment at a given point in time. The endowment, as previously noted, is made up of a public domain from which knowledge is freely available to all and a private domain to which access is restricted by temporary intellectual property rights. There should, however, be some optimal rate of flow from the private to the public domain in order to grow the adjacent possible of yet more new knowledge – personal & tacit, codified and tooled. This optimum rate likely varies, however, between Nation-States.

2. Furthermore, given the specializing effects of comparative advantage, inevitably elements of the national knowledge endowment will atrophy. Some, however, may be

considered essential for the survival of the Nation-State, *i.e.*, reproduction of its citizens and their distinctive national life ways. The classic example is the Japanese trade argument that rice is a strategic commodity whose domestic production is essential for the survival of Japan and Japanese culture. Such critical elements also vary between countries.

3. As national economic policy, autarky, *i.e.*, national self-sufficiency in all economic inputs and outputs, was discredited by the WWII defeat of the NAZI drive for *Lebensraum* or living space, and the Japanese push for a Co-Prosperity Sphere in Asia. The Cold War, however, gave it new life in the guise of ideological ‘blocs’. Each side in the Market/Marx Wars struggled to achieve self-sufficiency relative to the other. Nation-States within each bloc adjusted to comparative advantage within that bloc, not to a global economy. They also submerged *cum* Huntington (1993) internal cultural differences in the face of a common foe.

4. With the collapse of the Communist Revolution the fitness landscape was altered by a massive avalanche of change. No longer was bloc self-sufficiency the raging question echoing through the halls of the noösphere. Rather it became how a Nation-State could survive in a free-for-all global marketplace. Creation of the WTO in 1995 provided a framework for global competition but it also amplified the search for comparative advantage, *e.g.*, using national innovation systems to foster necessary specialization. This applies to the largest Nation-States as well as the smallest. Thus some industries in traditional First World countries melted off their fitness peaks as their de-industrialization was paralleled by the rapid industrialization of others, *e.g.*, China, India, South Korea and Taiwan.

5. While the benefits of trade are undeniable, the question nonetheless arises whether pursuit of unbridled specialization reduces the ability of Nation-States to survive future environmental changes such as a possible bird flu pandemic that could arguably shut down the entire global economy. Some Nation-States have responded by forming regional trading blocs like NAFTA and the EU to maintain some level of self-sufficiency and survivability. In the process, however, many smaller Nation-States have, in effect, given up their right to self-reproduction. They are now codependent. They have been effectively absorbed like mitochondria, internalized as components of a larger and more complicated organism, a higher order autonomous agent. Those that choose not to be internalized must maintain and subsidize redundancy in industries considered strategic for national survival. In the long-run, however, the inevitable logic of a global economy is increasing division and specialization of production in accordance with comparative advantage.

15.3.3 Econology?

1. A global economy seen in biological terms raises radical questions about economics itself. The word ‘economy’ derives from the ancient Greek *oikos* meaning ‘house’ and *nemo* meaning ‘manage’, *i.e.* managing the house. It shares its root with:

- ecology from *oikologie* meaning modes of life and relations within the house; and,
- ekistics, or the science of human settlement (Doxiadis 1976), also from *oikos* but carrying the ancient Greek sense of founding a colony like Syracuse in Sicily or the many city states established by Alexander the Great in India at the end of the 4th century B.C.E.

2. The question becomes what is the appropriate ‘house’ needing management? Its original sense was the self-sufficient ancient estate. Its management, however, ascended to progressively higher orders of human settlement as the village, town and city (Steiner 1976).

3. While Adam Smith moved management up to the level of the State, arguably a detour occurred during the Market/Marx Wars. Mainstream market economics turned away from questions about management of the State and towards management of the firm. Microeconomics was born. It was not until John Maynard Keynes’ *General Theory* in 1936 that macroeconomics returned and the modern system of national income accounting was born. Nonetheless, mainstream resistance to overt economic management of the Nation-State continues, witness the dominant policy role played by the school of rational expectations and the monetarists.

4. In a global knowledge-based economy such resistance is futile. Such an economy can only exist because of the Nation-State, not in spite of it. It defines the rules of the game, its tokens and talismans – intellectual property rights. And it enjoys more degrees of freedom to foster comparative advantage in IPRs than in any other industrial sector covered by the WTO.

5. But seventy years after Keynes’ *General Theory* economics now confronts a global knowledge-based economy with the visible and global consequences of human technology progressively, and in my opinion inevitably, enframing more and more of the geosphere and biosphere enabling it, making it ready at hand to serve human purpose. This is the way of life. In effect, the globe has become the house in need of management. If mainstream economics cannot find its way then perhaps a new discipline of thought, perhaps out of the old American Institutionalism (Blaug 1997, 700) rooted in biology and law rather than physics, may be in order. I offer therefore, as my last word, the neologism: *Econology*.

A Dieu?

06/07/31

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